Morbidity with retroperitoneal procedures during endovascular abdominal aortic aneurysm repair

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Purpose: Retroperitoneal iliac procedures can enable successful endovascular repair of abdominal aortic aneurysm (AAA) in patients who otherwise would not be anatomically eligible. The purpose of this study was to determine perioperative outcome with adjunctive retroperitoneal procedures compared with standard bilateral femoral exposure.

Methods: Between August 1997 and November 2002, 164 patients underwent elective endovascular AAA repair at a single university medical center. Anatomic, demographic, and early postoperative outcome data gathered prospectively were analyzed. Thirty-two patients (20%) underwent 38 separate adjunctive retroperitoneal procedures. Indications included small external iliac arteries (16 of 32 patients; 50%) and concomitant iliac aneurysm that precluded fixation of the endograft limbs in the common iliac arteries (16 of 32 patients; 50%). The 38 procedures consisted of 8 iliac conduits only, 14 iliac conduits with iliofemoral bypass grafts, and 16 hypogastric revascularization procedures. Data for the study patients were compared with data for 132 patients who underwent endovascular AAA repair through femoral incisions. Primary end points were hospital length of stay, and early morbidity and mortality.

Results: Retroperitoneal procedures enabled an additional 14% of patients with AAA to undergo endovascular techniques. However, there was a significantly higher proportion of women and patients at high risk for anesthesia (American Society of Anesthesiologists class IV or higher) in the group who underwent retroperitoneal procedures. On average, retroperitoneal procedures were associated with 2.6-fold greater blood loss, 82% longer procedure time, 1.5 days additional hospital stay, and 1.8-fold higher rate of perioperative complications, compared with endovascular AAA repair with femoral exposure alone. In contrast, early mortality was similar in the two groups.

Conclusion: Adjunctive retroperitoneal procedures during endovascular AAA repair are associated with increased risk for complications and longer hospital length of stay, compared with AAA repair with standard femoral exposure only. They do not, however, increase early mortality, even in patients at high risk, and enable a larger subset of patients with AAA to undergo endovascular repair. (J Vasc Surg 2003;38:459-65.)

More than 13,000 endovascular abdominal aortic aneurysm (AAA) repair procedures are performed in the United States each year. Three devices are currently commercially available (Ancure; Guidant/EVT, Menlo Park, Calif; AneuRx, Medtronic/AVE, Santa Rosa, Calif; and Excluder, W. L. Gore & Associates, Flagstaff, Ariz) that may be used for these procedures, and at least seven others are under various stages of clinical investigation. Although individual designs in construction and deployment differ in several substantive ways, each device has been designed for use in a similar subset of infrarenal aortoiliac anatomy, including proximal aortic neck diameter 18 to 26 mm, minimum neck length 15 mm, common iliac artery diameter 8 to 15 mm with minimum contiguous length 20 mm, and common femoral and external iliac artery diameter greater than 7 mm, to enable safe passage of the delivery catheters. Other anatomic considerations (eg, angulation, tortuosity, thrombus) may collectively be important in proper patient selection, but the physical dimensions of the proximal and distal fixation sites are the most critical limiting factors for success or failure of the procedure.

Previous studies have estimated that, with these criteria, approximately 30% to 60% of patients with AAA are anatomically suitable for endovascular repair. As surgeons have gained experience with these devices, unique adjunctive surgical techniques have been developed to manage complex iliac anatomy through limited pelvic retroperitoneal exposure, which, while preserving the minimally invasive benefits of these procedures, have expanded the subset of patients who may undergo endovascular procedures.

We studied the perioperative morbidity and mortality associated with these adjunctive retroperitoneal procedures, as compared with conventional bilateral femoral exposure, during endovascular AAA repair.

METHODS

Between August 1997 and July 2000, 19 patients underwent endovascular AAA repair during the early phase of the aortic endovascular program. From August 2000 to November 2002, a systematic protocol for routine screening of all patients with intact infrarenal AAA who met clinical indications for repair was implemented to determine anatomic eligibility for endovascular treatment. During these latter 28 months 241 patients with infrarenal AAA
underwent either open surgical (n = 95, 39%) or endovascular repair (n = 146, 61%). Of the 95 patients who underwent open surgical repair, 24 were anatomic candidates but did not undergo endovascular repair, because of patient preference (19 patients), surgeon preference (1 patient), device unavailability (2 patients), or misinterpretation of preoperative computed tomography (CT) scans (2 patients). All patients were evaluated and underwent treatment at a single, tertiary care university medical center by a group of six board-certified vascular surgeons. The primary preoperative imaging method was spiral CT angiography, with three-dimensional reconstructions, including surface shaded renderings and multiplanar reconstructed images. Conventional preoperative angiography was performed in fewer than 10% of patients. All procedures were performed with the patient under general endotracheal anesthesia in the operating room, with a portable fluoroscopy unit (GE-ÖEC, Salt Lake City, Utah).

Over the entire study period 165 patients (August 1997–July 2000, n = 19; August 2000–November 2002, n = 146) underwent endovascular AAA repair. AneuRx stent grafts were used in 142 patients, Ancure in 11 patients, and Vanguard (Meditech/Boston Scientific, Natick, Mass) in 12 patients. In 1 patient undergoing attempted repair with an AneuRx device, intraoperative conversion to open surgery was required after misdeployment of the primary bifurcated device almost entirely into an aneurysmal ipsilateral common iliac artery, precluding any chance for cannulation of the contralateral limb opening. This patient was excluded from the current study, leaving a final cohort of 164 patients, with a technically successful procedure completion rate of 99.4%.

In 32 of 164 patients (20%) one or more adjunctive retroperitoneal iliac procedures were required to facilitate endovascular AAA repair, whereas in 132 patients repair was performed successfully via femoral exposure. Indications for retroperitoneal procedures included internal iliac (hypogastric) artery revascularization (16 of 32 patients, 50%) and small external iliac arteries (16 of 32 patients, 50%). Choice of arterial access was made on the basis of the largest diameter of the external iliac artery as measured at preoperative CT angiography, along with qualitative assessment of the tortuosity and calcification. The only absolute indications for primary retroperitoneal iliac access were bilateral small (<8 mm) external iliac arteries or borderline arteries with significant combination of calcification and tortuosity. If, however, one external iliac artery was small and the other of adequate size, attempts were made to pass the larger of the two sheaths through the larger artery and the smaller sheath through the smaller artery. Intraoperative angiography, direct assessment of the femoral artery after surgical exposure, failure of serial dilation, and balloon angioplasty all were secondary considerations in the decision to obtain retroperitoneal access. Previous groin procedures (eg, vascular bypass, hernia repair) were not indications in and of themselves for a retroperitoneal approach.

Femoral exposure Femoral exposure consisted of a 5 cm transverse oblique incision made 1 cm inferior to the inguinal ligament. The femoral artery was catheterized via assisted percutaneous arterial puncture performed under direct vision. All retractors were removed, and the incision was allowed to collapse for the duration of the procedure except during exchange of introducer sheaths. Purely percutaneous entry, even for the smaller contralateral sheaths (12F), was not used. All femoral arteries were repaired primarily, with endarterectomy and prosthetic patch angioplasty, or with a short prosthetic interposition graft, and the incisions were closed routinely in multiple layers.

Retroperitoneal exposure. Pelvic retroperitoneal iliac exposure involved a 10 to 15 cm curvilinear incision centered at approximately half the distance between the umbilicus and the anterior superior iliac spine. The anterior rectus sheath was sharply incised along its lateral border, and the ipsilateral rectus muscle was retracted medially to gain access to the retroperitoneal space. This is an entirely muscle-sparing approach to the pelvic retroperitoneum, which is simply closed with reapproximation of the anterior rectus sheath. The approach reliably exposed the iliac bifurcation, from which an iliac conduit based off the distal common iliac artery, hypogastric artery bypass or transplantation, and iliofemoral bypass may all be readily performed. These procedures have been previously described. In brief, in small or diseased external iliac arteries, an iliac conduit is constructed of a 10 mm Dacron graft anastomosed end-to-side to the iliac bifurcation. The other end is tunneled through the inguinal ligament to the groin through a small stab incision made directly over the common femoral artery. This enables a smoother angle of entry for the sheaths into the iliac artery. After distention under arterial pressure, all catheter and guide wire manipulations are performed through this conduit, completely bypassing the diseased external iliac artery. This conduit may be amputated at its base and oversewn after completion of the endovascular procedure; alternatively, if the external iliac or femoral pulse is diminished, the conduit may be retunneled anatomically below the inguinal ligament and anastomosed to the femoral artery as an iliofemoral bypass graft.

All patient data were prospectively gathered in a dedicated aortic endovascular database, which included standard demographic information, cardiovascular risk factors, and pertinent preoperative anatomic, intraoperative procedural, and postoperative follow-up data. Preoperative cardiovascular risk factors included previous history of hypertension, coronary artery disease (angina, coronary artery bypass grafting, percutaneous coronary angioplasty), peripheral occlusive disease (claudication, ankle-brachial index <0.9, leg revascularization), chronic obstructive pulmonary disease, diabetes mellitus, chronic renal insufficiency (serum creatinine concentration >1.3 mg/dL), congestive heart failure (New York Heart Association class II or greater), cerebrovascular occlusive disease (transient ischemic attack, stroke, carotid endarterectomy), and arrhythmia (atrial fibrillation, stable ventricular or atrial ectopy). Preoperative risk stratification was based on the American Society of Anesthesiologists (ASA) Physical Status Classification system. (Note: The original classification...
has been revised many times, most recently in 1961.) High risk was defined as ASA class IV (severe systemic disease that is an ongoing threat to life) or higher. External iliac arteries were considered small if they were less than 8 mm in diameter. Common and hypogastric arteries with focal diameter 20 mm or greater were considered aneurysmal. Postoperative data included detailed records of all complications and device-related secondary procedures. All patients, regardless of whether they underwent retroperitoneal-assisted or femoral-only endograft procedures, were admitted to the general care ward, without intensive care unit observation.

Perioperative outcome for the 32 patients who required retroperitoneal procedures were compared with that for the 132 patients in whom endovascular AAA repair was performed through femoral exposure alone. The primary end points of the study were perioperative death and complications, and total hospital length of stay. Perioperative was defined as all intraoperative, postoperative in-hospital, and outpatient 30-day procedure-related events. All categorical data were analyzed with the Fisher exact test, and continuous data were analyzed with the Student t test and the Wilcoxon rank-sum test. P < .05 (two-tailed) was considered significant. All values, unless otherwise specified, are given as mean ± SD.

RESULTS

Patient demographic data. Age, body mass index, and mean number of cardiovascular risk factors per patient were similar between the femoral group (femoral access only, n = 132) and the retro group (adjunctive retroperitoneal procedure, n = 32; Table I). However, there was a significantly greater proportion of women, incidence of peripheral vascular occlusive disease, and patients at high risk in the retro group compared with the femoral group. While proximal neck dimension was similar between the two groups, maximum AAA diameter was almost 5 mm larger in the femoral group than in the retro group (Table II). Forty-eight (29%) of the overall group of 164 patients had one or more concomitant iliac aneurysms, with a significantly greater proportion of patients with iliac aneurysm in the retro group than in the femoral group. In addition, patients in the retro group more commonly had two or more iliac aneurysms (retro group, 11 of 15 patients, 73%; femoral group, 7 of 33 patients, 21%; P = .001).

Procedural data. The distribution of devices in the femoral and retro groups is shown in Table III. In the femoral group, 16 patients (12%) had either unilateral (n = 9) or bilateral (n = 7) small external iliac arteries at preoperative imaging. In the 9 patients with unilateral small external iliac arteries, the contralateral external iliac artery was large enough to pass the larger introducer sheath (>22F), and the side with the small external iliac artery allowed passage of the smaller introducer sheath (16F-12F), thereby enabling complete transfemoral access. For the 7 patients who had bilateral small external iliac arteries, however, the decision to attempt transfemoral passage of the introducer sheaths was made intraoperatively on the basis of qualitative assessment of the common femoral arteries. Sixteen of 132 patients (12%) in the femoral group required either common femoral endarterectomy with prosthetic patch angioplasty (14 patients) or common fem-
oral artery replacement with a short interposition graft (2 patients), because of significant arterial injury during passage of the larger introducer sheaths. Of these 16 patients, 3 had small external iliac arteries at preoperative evaluation.

In the retro group, 38 separate retroperitoneal procedures were performed in 32 patients, including construction of 8 iliac conduits (only), and creation of 14 iliofemoral bypass grafts and 16 hypogastric artery bypass grafts or transpositions. Four patients (13%) underwent bilateral retroperitoneal procedures. Two patients required prosthetic patch angioplasty to repair the common femoral arteries contralateral to the retroperitoneal iliac procedures, and 2 other patients underwent emergent retroperitoneal procedures to repair iliac artery rupture caused during passage of the introducer sheaths.

**Perioperative morbidity and mortality.** Early postoperative morbidity was similar between the two groups (retro group, 1 of 32 patients, 3%; femoral group, 2 of 132 patients, 2%; \( P = .48 \)). In the retro group, 1 patient died on postoperative day 26 of a myocardial infarction and sepsis from ischemic colitis after inadvertent bilateral hypogastric artery occlusion, on one side during anastomosis of the iliac conduit directly over a diseased hypogastric artery orifice, and on the other side from passage of the introducer sheath in a severely calcified external iliac artery. In the femoral group, 1 patient died on postoperative day 2, of colonic infarction after carbon dioxide angiography and likely gas embolization, and another patient died of unspecified cardiac event on postoperative day 12.

Both blood loss and procedure duration were nearly twice that in the retro group compared with the femoral group (Table IV). Median hospital length of stay in the retro group was 1.5 days longer than in the femoral group (3.5 days [range, 2-61 days] vs 2.0 days [range, 1-15 days]; \( P < .0001 \)). Two patients in the retro group were discharged on postoperative days 58 and 61, respectively. Each had significant chronic obstructive pulmonary disease preoperatively, and the hospital course was complicated with respiratory failure requiring tracheostomy. Both patients were alive and well at 17 and 16.5 months, respectively.

Incidence of perioperative complications was almost twice as high in the retro group compared with the femoral group (19 of 32 patients, 59%, vs 43 of 132 patients, 33%; \( P = .008 \)) (Table V). In particular, incidence of respiratory failure (6% vs 0%, \( P = .04 \)), ileus (delayed bowel function beyond 3 days, 6% vs 0%, \( P = .04 \)), and thrombotic complications (6% vs 0%, \( P = .04 \)) was significantly higher in the retro group than in the femoral group. Both thromboses were in the retro group, and involved one early thrombosis of a hypogastric bypass graft and one femoral thrombosis from an unrecognized dissection. At mean follow-up of 12 months (range, 1-26 months), 94% (15 of 16) of hypogastric revascularizations remained patent, as documented with follow-up CT scans and all 15 patients free of symptoms of hip or buttock claudication. Twelve inadvertent hypogastric occlusions occurred (Table V), from endograft maldeployment as a result of either misidentification of the hypogastric artery origin or incorrect selection of device length (n = 11) or iliac artery dissection at the hypogastric artery orifice (n = 1).

**DISCUSSION**

We compared early clinical outcome of endovascular AAA repair performed with adjunctive retroperitoneal procedures versus those done via femoral exposure only. The primary end points of the study were incidence of perioperative morbidity and mortality, and hospital length of stay. Our results indicated that, although adjunctive retroperitoneal procedures were associated with increased median length of stay and higher incidence of perioperative complications, early postoperative mortality was not increased. This was achieved despite the proportion of patients at high risk in the retro group being over twice that in the femoral group. This higher incidence of patients at high risk in the retro group likely represents referral bias, in which patients who pose both an unfavorable surgical risk and unfavorable anatomy for endovascular repair are preferentially referred to an endovascular tertiary care center.
The indications for adjunctive retroperitoneal procedures were need for hypogastric revascularization and iliac conduits because of small external iliac arteries. For common iliac aneurysms that are too large to allow a “bellbottom” technique with an aortic cuff, distal iliac fixation must be in the external iliac arteries. However, acute unilateral occlusion of patent hypogastric arteries (simple stent-graft coverage or coil embolization) may result in up to 40% risk for clinically significant hip and buttock claudication, as well as other complications of pelvic ischemia. Indeed, the 1 death in the retro group was due to severe colorectal ischemia after acute bilateral hypogastric occlusion. In the setting of common iliac aneurysm with planned extension to the external iliac artery, we have advocated elective hypogastric revascularization (vs embolization), with either hypogastric transposition to the external iliac artery or direct external iliac artery to hypogastric artery bypass grafting in patients with bilateral common iliac aneurysm with involvement of both hypogastric arteries or who are sufficiently ambulatory and do not wish to risk the 40% chance of hip or buttock claudication.

Patients preoperatively identified as having small external iliac arteries routinely underwent intraoperative diagnostic angiography during the endograft procedure before passage of the introducer sheaths. We have found that CT scans are more reliable for sizing the iliac arteries and predicting success (or failure) of a transfemoral approach than conventional angiograms, where even in the presence of angiographically significant occlusive disease the sheaths could be passed easily, and conversely, deceptively normal appearing iliac arteries posed significant resistance. Because of the substantial risks associated with iliac artery disruption or rupture, we have readily resorted to an iliac conduit.

Most patients in the retroperitoneal group with iliac conduits required only unilateral procedures, because the delivery catheters in the contralateral limbs of all three commercially available devices are significantly smaller than their corresponding primary bifurcated devices. The Ancure device requires a 24F (minimum vessel diameter >8 mm) primary introducer sheath and a 12F contralateral sheath, and the AneuRx device requires a 22F (minimum vessel diameter >7.5 mm) and a 16F contralateral sheath. Therefore, with small diseased arteries, whereas the contralateral device can usually be passed from the femoral artery in most situations, the primary device almost always requires retroperitoneal access. Of the 16 patients in the retro group who required an iliac conduit, only 1 received the Ancure device. Device type was not important in this patient who required iliac access; the patient had bilateral, severely diseased small external iliac arteries that would not have allowed passage of even the 22F sheath required of the AneuRx system. Serial dilation with special hydrophilic dilators (Endovascular Dilator Set; Cook, Bloomington, Ind) and balloon angioplasty was not successful in these patients. The Excluder system (Gore), which has been recently approved by the US Food and Drug Administration for commercial use, may offer a significant advantage in such situations. This device has the lowest profile of the three aortic endograft systems, with the primary bifurcated device requiring only an 18F (minimum vessel diameter >6.1 mm) introducer sheath and a 12F contralateral sheath.

Adjunctive retroperitoneal procedures during endovascular AAA repair have become part of the standard techniques used by most experienced endovascular aortic operators, and have served to significantly expand the subset of patients who may undergo endovascular techniques. Estimates of anatomic eligibility of unselected cohorts of patients with infrarenal AAA vary between 30% and 60% among published series. These estimates, however, comprise a heterogeneous mixture of criteria for anatomic eligibility, span both the early and late phases of an institution’s learning curve, and involve a variety of custom techniques to facilitate endovascular repair. Therefore it is probably safe to say that true estimates of anatomic eligibility based on strict guidelines are not known. With recognition of these limitations, however, during the 28 months when all patients with intact infrarenal AAA clinically indicated for repair were screened for endovascular treatment, 71% (170 of 241 patients [146 endovascular repair, 24 open surgical repair]) of patients who were anatomically eligible for endovascular techniques were able to undergo endovascular and adjunctive surgical techniques. If these ancillary methods were not available, at least 32 patients would not have been candidates for endovascular repair, which would have reduced the anatomic endovascular eligibility rate to 57%.

CONCLUSIONS

Adjunctive retroperitoneal surgical procedures can significantly expand the number of patients who can undergo endovascular repair. These same patients, however, sustain significantly more complications and require longer hospitalization after these procedures. Despite these outcome measures, adjunctive retroperitoneal procedures during endovascular AAA repair may still be performed safely without additional mortality in patients at high risk for whom options for AAA repair are limited.

REFERENCES


DISCUSSION

Dr William Jordan (Birmingham, Ala). Thank you, Dr Huber, Dr Hansen. First I want to congratulate Dr Lee on his eloquent presentation of the continued scholarly pursuits at the University of Florida. In this series he and his colleagues presented a 5-year experience with endovascular repair of 171 aneurysms. Most of the experience is in the last 22 years, which reflects a wave of endo-enthusiasm that has swept across our southern region and our country. The authors identified the ability to expand this minimally invasive approach to an additional 14% of their patients.

Speciﬁcally, this is most often related to the difﬁculty with the access through the iliofemoral segment to place these large-diameter endografts into the aneurysm proper. Dr Lee has demonstrated to us that the retroperitoneal approach can offer an approach for iliac conduit or for iliofemoral bypass or for direct hypogastric revascularization. While their operative time, blood loss, and total complication rate were increased, the overall mortality was signiﬁcantly lower. Anthony, you are still able to overcame those prohibitions of the gray-haired Gandalf, who suggested that you shall not pass. So, Anthony, Sir Balrog, how do you respond? Thank you.

Dr W. Anthony Lee. Will, thank you for that discussion. I think the current situation is that we have the skills to overcome some of these unfavorable iliac anatomies and that they, in and of themselves, should not deny somebody who may strongly wish an endovascular treatment of their aneurysms, and certainly if their comorbid status would make endovascular repair a more attractive option. Speciﬁcally, external iliac arteries that are less than 8 mm are a signiﬁcant risk factor for intraoperative complications. Indeed, two patients had inadvertent retroperitoneal exposures after external iliac artery ruptures. We have tried all sorts of adjunctive maneuvers, including serial, hydrophilic dilators and balloon angioplasties, and in a couple of cases we have actually put in a covered stent preoperatively to superdilate these arteries. None of these methods were successful in our hands. That is the main reason for going directly to these retroperitoneal conduits.

In regard to your question about the remaining 40% who were not eligible for endovascular repair, the 40% was due to proximal neck issues that could not be overcome. Did calcification play a role? Yes, certainly it did. Even in marginally sized arteries, if they are relatively free of calcifications, it is possible to pass 22F sheaths.

I would not term these retroperitoneal procedures, whether they are iliac conduits or hypogastric bypasses, as simple. I think they are fairly involved, and our data regarding their procedure time and postoperative morbidity also supports that. Why not, then, convert these or offer them an open aneurysm repair from the start? Well, the answers to that reflect what I said earlier about some people who strongly desire endovascular repair, or their comorbid status may sometimes sway one toward that route. Although the data are not presented in this paper, it is our retroperitoneal experience that, despite the incremental surgical stress of these procedures, when you see them back in clinic they are functionally better than people who have undergone open aneurysm repair.

With regard to the indications for hypogastric artery bypass, about 3 years ago three papers were published in two separate