ABDOMINAL AORTIC ANEURYSM REPAIR AND CONCURRENT DISEASE
Bradley B. Hill
Christopher K. Zarins

An abdominal aortic aneurysm (AAA) should be repaired when symptomatic and when reaching a diameter that presents a significant risk of rupture. Open repair is the current standard of care. When a surgeon embarks on repair of an AAA, other disease states may coexist. These additional entities must be evaluated independently, and the surgeon must decide whether to treat the problems sequentially or concurrently.

COEXISTING DISEASE STATES

The common disease states that coexist with AAAs include hepatobiliary, pancreatic, gastrointestinal, genitourinary, and structural abnormalities of the abdominal wall. Disease states can be broadly categorized as either symptomatic or asymptomatic. If an AAA is asymptomatic, but its size warrants repair and the underlying disorder is symptomatic or life threatening, repair of the aneurysm should be postponed until the other problem is resolved. Rarely will a symptomatic or expanding aneurysm and a symptomatic concurrent disease process present simultaneously. In such a situation, both problems must be addressed, and a successful outcome depends on careful preoperative planning and perfect technique at the time of operation. Preoperative studies that may help elucidate the source of abdominal complaints include ultrasonography, computed tomography (CT), magnetic resonance imaging, and nuclear scintigraphy studies. However, the patient’s history and findings on physical examination commonly provide the most valuable diagnostic information.

The propensity of an AAA to rupture after an abdominal operation for another problem is a possibility the surgeon must consider. No clinical studies have clearly documented that unrelated abdominal operations increase the risk of AAA rupture; however, aneurysm rupture has occurred less than 3 weeks after bowel resection, cholecystectomy, and plastic operations. Swanson and colleagues postulated that increased collagenase activity following other surgical procedures may increase the risk of AAA rupture. Certainly AAAs 5 cm or more in diameter and those with saccular morphology should be treated sooner rather than later after other abdominal operations, if the aneurysm repair must be performed secondarily.

When the surgeon encounters a symptomatic or ruptured AAA and a grossly contaminated peritoneal cavity in association with a diverticular abscess, perforated peptic ulcer, or suppurative cholecystitis, surgical treatment becomes more complicated. The aneurysm must be excluded. This may require oversewing of the infrarenal aorta and lower extremity revascularization by either axillofemoral and femorofemoral bypass or in-line aortic reconstruction. If in-line reconstruction is performed, cryopreserved allograft aorta or autogenous superficial femoral vein is most desirable; however, reconstruction with a polytetrafluoroethylene (PTFE) graft on occasion may be necessary, if there are no other options available. Some authorities argue that PTFE grafts are preferable to knitted or woven polyester grafts in contaminated and infected tissue fields because of a higher resistance to infection. Long-term intravenous antibiotic therapy is indicated following any of the aforementioned reconstructions.

Several important principles apply in most instances of AAA and concurrent abdominal disease, such as follows:

1. Preoperative imaging and evaluation usually eliminate any surprise of concomitant disease and allow preoperative planning and staging as appropriate.
2. When intraabdominal conditions come into play in emergency situations such as a ruptured or symptomatic aneurysm and no preoperative imaging (CT scan) is done, the AAA always takes priority. If the other condition is clearly life threatening and the aneurysm is stable and not the cause of the patient’s symptoms, then the other condition should be addressed initially.
3. A retroperitoneal approach can avoid almost all concomitant intraabdominal conditions, including adhesions and scarring from previous operations, thus obviating many problems.
4. Endovascular aneurysm repair can avoid concomitant intraabdominal problems even more, but it will not resolve intestinal obstruction or other life-threatening conditions. However, endovascular repair of an inflammatory AAA might resolve ureteral obstruction.

The following sections address management strategies for specific disease entities that may be discovered preoperatively or incidentally during AAA repair.

Galbladder and Biliary Tract

In the United States, cholelithiasis affects approximately 10% of the general population and 25% to 35% of elderly men and women who reach the age of 90 years without having undergone cholecystectomy. Because the 60- to 80-year-old age group is most commonly affected by aortic aneurysmal disease, many of these patients also have cholelithiasis. Multiple epidemiologic studies have concluded that silent gallstones do not require cholecystectomy. Gracie and Ransohoff found that for faculty members at the University of Michigan who had asymptomatic cholelithiasis, the cumulative probability of developing gallstone-related symptoms or complications was only 18% over a 15-year period. Asymptomatic cholelithiasis diagnosed incidentally during preoperative evaluation or during aneurysm repair is not an indication for cholecystectomy. If the patient has a history of symptomatic cholelithiasis or choledocholithiasis, aneurysm repair and cholecystectomy are both indicated. The order in which operations are performed should be based on which
problem places the patient at greatest risk: AAA rupture or acute biliary tract disease.

Some authorities advocate AAA repair and cholecystectomy at the same operation, with the rationale being to avoid two anesthetics and the potential for cholelithiasis-related complications during the convalescence period after aneurysm repair. If concomitant procedures are performed using a transabdominal approach, the AAA repair is completed first. The graft is then retroperitonealized, and the gallbladder is isolated with surgical packs. Care is taken not to perforate the gallbladder. The cystic duct is ligated and divided with electrocautery. The area is then copiously irrigated with normal saline or antibiotic solution, and the abdomen is closed without placement of surgical drains. If the AAA repair is performed through a retroperitoneal approach, the cholecystectomy can be performed laparoscopically as the secondary procedure after repositioning the patient.

Patients with asymptomatic AAAs and cholecystitis should be treated with cholecystectomy, followed by elective aneurysm repair 1 to 2 weeks later. Patients with suppurative cholecystitis, gangrenous cholecystitis, or gallbladder perforation require longer recovery periods of 3 to 4 weeks before elective AAA repair with interval CT imaging to ensure that no intraabdominal sepsis is present. In rare circumstances a patient may be encountered with a rapidly enlarging or acutely symptomatic AAA and an acutely suppurative or gangrenous cholecystitis. In these circumstances, both a cholecystectomy or cholecystostomy and an aneurysm repair must be carried out. If no gross peritoneal contamination is present, the AAA should be repaired first. After closing the retroperitoneum, cholecystectomy should be performed as previously described. If the peritoneal cavity is grossly contaminated, aneurysm exclusion and either extraanatomic lower extremity revascularization or in-line reconstruction must be carried out. Perioperative antibiotics should be administered, and culture-specific antibiotic therapy may be indicated for several months postoperatively.

Pancreatic Disorders
Common pancreatic diseases include cysts, benign and malignant tumors, pancreaticitis, abscesses, and pseudocysts. A coexistent pancreatic abscess or symptomatic pancreatic pseudocyst should be treated before elective AAA repair. Other incidental pancreatic abnormalities found at the time of aneurysm repair should be treated on their own merits, usually after the patient has recovered sufficiently from the AAA repair. Thorough evaluation of the pancreas, its draining lymph nodes, and the liver should be performed and accurately documented. Needle biopsy of a pancreatic mass after completing the aneurysm repair and retroperitonealizing the graft can provide valuable diagnostic information.

Chronic pancreatitis may result in significant retroperitoneal fibrosis in the region of the proximal AAA neck. A left retroperitoneal approach may be helpful for gaining adequate exposure, and careful dissection and meticulous technique are required. Patients who have significant retroperitoneal fibrosis may be considered for endoluminal graft repair of their AAA, if the risk of open operation is high.

Liver Disease
Liver tumors or abscesses discovered on preoperative CT imaging for AAA should be treated independent of the aneurysm. Liver abscesses should be treated with antibiotics and drainage as indicated. Aneurysm repair should be delayed until the liver abscess has resolved. If the AAA is enlarging or symptomatic and requires urgent repair, it should be approached retroperitonally through the left flank to avoid intraperitoneal exposure of the aneurysm.

Liver tumors should be treated on an independent basis when they coexist with AAA with judgment guided by a relative risk analysis of the two diseases. If aneurysm repair is indicated, the aneurysm should be repaired first. Incidental discovery of liver masses at the time of abdominal exploration before elective aneurysm repair should be noted. The planned AAA repair should be performed with biopsy of the liver tumor after retroperitonealizing the graft. Resection of small liver tumors may be carried out as long as blood loss does not complicate the aneurysm repair.

Upper Gastrointestinal Tract
Gastric and colonic diseases are the most common intestinal disorders found concurrently with AAAs. The treatment of uncomplicated peptic ulcer has become largely medical, yet perforated ulcers usually require surgical intervention. Patients with concurrent AAA and peptic ulcer often present with abdominal pain. The evaluation may include endoscopy and upper gastrointestinal barium studies or CT that may suggest the presence of both entities. When an aneurysm is symptomatic, it should be treated first. If the ulcer disease is quiescent, AAA repair can be carried out with administration of an ulcer prophylaxis medication perioperatively using an H₂-blocking agent, such as ranitidine, or a proton pump inhibitor, such as omeprazole. If the presence of Helicobacter pylori is documented, an appropriate bactericidal regimen should also be administered, such as amoxicillin 500 mg 3 times daily, metronidazole 500 mg 3 times daily, and bismuth subcitrate 300 mg 4 times daily. If a perforated ulcer with peritoneal contamination coexists with a symptomatic or ruptured AAA, both problems must be treated with a strategy similar to that previously described for concurrent infectious processes.

The combination of gastrointestinal bleeding and a pulsatile abdominal mass should alert the physician to the possibility of an aortoenteric fistula. Oftentimes a herald bleed occurs, followed by eventual exsanguination and death if repair of the fistula is not performed promptly. Primary aortoenteric fistulae are extremely rare, with fewer than 250 reported. They are most commonly associated with atherosclerosis and occur between native aorta and the duodenum. Secondary fistulae usually involve the duodenum and a previously reconstructed aorta or aortic graft. Secondary fistulae can be associated with failed endoluminal aortic grafts placed for treatment of aneurysmal disease. False aneurysm formation at the proximal graft anastomosis is the most common associated anatomic finding. Graft erosions into bowel may also occur without an associated false aneurysm or bleeding but rather bowel obstruction, sepsis, abscess formation, graft thrombosis, or a combination of complications.
An isolated primary aortoenteric fistula is considered sterile and should be treated like a ruptured aneurysm. This may require suprarenal or supraceliac aortic control. Repair of the small bowel defect can usually be performed primarily, and the aneurysm is repaired with a prosthetic graft. Secondary aortoenteric fistulae are considered infected. Standard treatment includes removal of the prosthetic graft, oversewing of the infrarenal aorta, and extra-anatomic bypass for lower extremity revascularization. Autogenous superficial femoral vein and fresh and cryopreserved allografts have also been used for in-line aortic reconstruction.\(^2,3\) Gastric-bowel erosions likewise require graft removal and extra-anatomic arterial reconstruction. Despite often heroic efforts, mortality in these patients is high, ranging from 33% to 85% for primary fistulae.\(^4\)

Occasionally a patient will have complaints of persistent vomiting after meals, and radiographic studies of the upper digestive tract will verify gastric outlet obstruction. These patients deserve a thorough evaluation preoperatively to identify other potential sources of intestinal obstruction. Endoluminal graft repair of AAAs in this situation is not recommended because the mass effect of the aneurysm is not ameliorated. These patients should undergo open AAA repair, and the abdominal cavity should be carefully explored for other sources of intestinal obstruction. If an obstructing gastric tumor is discovered preoperatively, gastroscopy and biopsy of the tumor should be performed. The decision whether to resect a gastric tumor or repair the AAA first can be difficult to make and requires good judgment and experience on the part of the surgeon.

**Lower Gastrointestinal Tract**

Colonic neoplasm and AAA are two entities that coexist often enough that most vascular surgeons will encounter the combination. The most threatening problem should be treated first; for example, an obstructing, bleeding, or perforated colon cancer should be resected before treating an asymptomatic 4.5-cm AAA. Likewise, a symptomatic or ruptured AAA should be treated before electively resecting an asymptomatic colon cancer. A dilemma arises when both entities are asymptomatic. In this situation, treatment should be based on the size of the aneurysm. If the aneurysm is small, the colonic lesion should be treated first and the aneurysm repair postponed. If, however, the aneurysm is large, 5 cm or more in diameter, the AAA should be repaired and the colon lesion resected later.

When a symptomatic or ruptured AAA coexists with an obstructing colon cancer, one acceptable method is to repair the aneurysm first, followed by externalization of a loop of colon proximal to the obstructing tumor. Colostomy maturation can then be performed outside the abdominal cavity on the first postoperative day, thereby avoiding vascular graft contamination.

A diverticular abscess and diverticulitis in the presence of an AAA must be treated initially, if the aneurysm is asymptomatic and not rapidly expanding. A diverting colostomy and antibiotic therapy followed by elective aneurysm repair soon after resolution of the infectious process is the appropriate treatment sequence (Figure 1). It is important that AAA repair not be delayed beyond a few weeks because the incidence of rupture increases. In the rare scenario of active diverticular disease and symptomatic or ruptured AAA, both processes must be treated as previously described for coexisting intraabdominal infectious processes.

**Genitourinary Disorders**

Urinary tract infection (UTI) is perhaps the most common infectious process that coexists with AAA. Many UTIs are...
subclinical, especially in women, and are detected only on routine urinalysis and urine culture during preoperative evaluation. Such asymptomatic UTIs may pose a theoretical risk of graft infection, if bacteremia occurs during instrumentation of the urinary tract as might occur when a catheter is placed into the bladder. Placement of a urinary catheter the evening before the operation, fluid hydration, and administration of appropriate antibiotics are acceptable treatment before elective aneurysm repair. If the UTI is symptomatic or other signs and symptoms of systemic infection are present, such as fever, dysuria, urinary frequency, or leukocytosis, antibiotics should be administered and AAA repair should be postponed until the UTI has resolved.

Renal and bladder neoplasms include a broad spectrum of benign and malignant entities. Concurrent renal or bladder neoplasms and AAA deserve independent assessment and treatment by respective specialists. The entity deemed most life threatening should be treated first. Partial, total, or radical nephrectomy may be indicated. The vascular surgeon should involve urologic and oncologic colleagues preoperatively to enhance the effectiveness of a multidisciplinary treatment approach. The patient who has a symptomatic or ruptured AAA and who is found at operation to have an incidental renal mass should have the aneurysm repaired. The renal mass should be addressed on its own merits as soon as the patient has recovered from the aneurysm repair.

Patients with large AAAs occasionally have ureteral obstruction from compression by the aneurysm. These patients may have associated renal insufficiency or postobstructive renal failure. Hemodialysis may be indicated for treatment of fluid overload, acid-base disorder, electrolyte abnormality, or complications of uremia. Endoscopic placement of ureteral stents in the preoperative period may be critical for correcting the uropathy and for following the patient's urine output perioperatively. If significant inflammatory changes are present around the ureter, ureterolysis or prolonged ureteral stent placement may be necessary. In most instances, hydrenephrosis will resolve after aneurysm repair, if inflammation or extrinsic compression is the cause.

Gynecologic Disease and Rare Tumors

Incidental ovarian cysts and tumors are sometimes encountered during AAA repair. Simple cysts can be safely excised. However, women who have AAAs are almost always beyond the childbearing years, and the risk of a woman developing ovarian cancer during her lifetime is approximately 1.8%. Bilateral oophorectomy is justified, especially if a solid ovarian abnormality is encountered. Staging of the tumor should include peritoneal washings for cytology and biopsy of periaortic lymph nodes, omentum, and undersurface of the diaphragm. Postoperative chemotherapy may be indicated if findings are positive. Hysterectomy is indicated in cases of solid ovarian tumors; however, this should not be performed in conjunction with AAA repair because of the increased risk of graft contamination and infection and the risk of additional blood loss.

Asymptomatic uterine tumors that are found incidentally at the time of AAA repair should be evaluated and treated later on their own merits unless an infectious process is involved. Tubulo-ovarian abscess and pelvic inflammatory disease are rare in the AAA population; however, these disorders may cause symptoms and should be treated first followed by aneurysm repair at a later time.

Neoplasms infrequently encountered during evaluation or treatment of AAA include lymphoma, adrenal neurogenic lesions, soft tissue tumors, metastatic lesions, and small bowel neoplasms. Rare tumors can be excised, if small. Otherwise, true-cut or incisional biopsy may be performed followed later by additional treatment.

Trauma and Disease of the Spine

Patients with penetrating abdominal trauma are usually young and do not have AAAs. Associated bowel and visceral organ injury are common. Control of hemorrhage must be the surgeon's primary objective. If a low-velocity bullet or stabbing is responsible for the injury, primary repair of the aorta with polypropylene sutures may be sufficient. If a large portion of the aorta is damaged, autogenous vein or prosthetic graft material can be used for aortic patch reconstruction. Prosthetic tube or bifurcation reconstruction may be required in patients with extensive damage to the aortic bifurcation. The pararenal and paravisceral aorta can often be repaired with a patch, with care taken to minimize supraceliac cross-clamp time. Prosthetic graft materials should be avoided in instances of gross intraperitoneal contamination. Greater saphenous vein, superficial femoral vein, or cryopreserved allograft may be used as a patch material under such circumstances.

Spine abnormalities are occasionally associated with aortic disease. Rarely will a spine neoplasm or degenerative process incite disease of the aorta. AAAs, however, are sometimes associated with degenerative erosion of the spine. This process is likely caused by vertebral body pressure necrosis and bone remodeling over time. In such patients, aortic replacement and concomitant anterior spine fixation can be performed by the concerted efforts of the vascular surgeon and spine surgeon.

Abdominal Wall

Patients who have aortic disease and a history of a previous abdominal operation especially through a midline incision may have ventral, umbilical, or incisional hernias. Concomitant aortic reconstruction and standard incisional hernia repair can be performed, if a midline incision is made. Known asymptomatic or symptomatic inguinal hernias can also be repaired at the time of aortic reconstruction. Inguinal hernias are sometimes discovered incidentally. These hernias should be repaired separately on their own merits with informed consent unless an immediate problem is discovered at AAA repair, such as incarceration of bowel.

The left retroperitoneal approach avoids most concomitant intraabdominal problems and may be associated with reduced intraoperative fluid and blood loss, decreased postoperative respiratory support requirements, a lower incidence of postoperative ileus, a shorter hospitalization, and lower total hospital costs.6,7

Endovascular aneurysm repair, first described by Parodi, Palmaz, and Barone in 1991,5 is a promising new technology that may be particularly useful in patients with aneurysms and concomitant intraabdominal disease. This approach requires limited femoral artery or occasionally iliac artery exposure for access. Preliminary results indicate that en-
vascular aortic aneurysm repair is associated with a lower complication rate, shorter hospital stay, and faster overall recovery than open repair.\textsuperscript{9,10} Clearly, if endovascular aneurysm repair is safe and effective and has less associated morbidity than open repair, patients who require AAA repair and additional abdominal operations for concurrent diseases may be among the best candidates for this new technology.

\textbf{References}


\textbf{RETROPERITONEAL APPROACH FOR ELECTIVE ABDOMINAL AORTIC REPAIR}

Jeffrey M. Reilly
Gregorio A. Sicard

\textbf{CONTRAINDICATIONS}

Many indications for the retroperitoneal approach to the infrarenal aorta have been reported. The most commonly quoted indication has been the hostile abdomen, usually the result of multiple transabdominal gastrointestinal or vascular operations, presence of urinary or enteric stomas, or abdominal or pelvic irradiation. With increased experience, various groups have added other indications, such as aortic pathologic condition in patients with ascites or patients undergoing peritoneal dialysis, morbid obesity, inflammatory aneurysms, aortic pathologic condition associated with renal ectopia or horseshoe kidney, as well as juxtarenal and infradiaphragmatic suprarenal aortic pathologic findings. This approach has also been found to be very useful in unilateral aortorenal or iliorenal revascularization. The most controversial and debatable indication remains the use of this approach for routine aortic reconstruction.

There are few contraindications to the use of the retroperitoneal approach in aortic reconstruction. Relative contraindications are (1) ruptured infrarenal aortic aneurysms, (2) aortic pathologic condition associated with right renal artery stenosis, (3) AAAs with associated right iliac aneurysms, and (4) aortic aneurysms with a left-sided vena cava. The retroperitoneal approach for ruptured infrarenal AAAs has been successfully reported by Chang and collaborators.\textsuperscript{5} The authors prefer the transabdominal approach for the common left-sided retroperitoneal rupture but use the retroperitoneal approach in cases of contained AAA rupture or the unusual right-sided rupture. The left retroperitoneal approach can be used in aortic reconstruction and right renal artery reconstruction if the renal artery stenosis is