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Evolving strategies for the treatment of aortoenteric fistulas

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Background: **Aortoenteric fistulas (AEFs) are a rare but often fatal cause of gastrointestinal bleeding. Operative repair of AEF has been historically associated with extremely high morbidity and mortality. We reviewed our experience of open surgical and endovascular treatment of AEF to compare outcomes over a contemporaneous time period.**
Methods: **Over a 9-year period between January 1997 and January 2006, 16 patients (11 men and 5 women) were diagnosed with and treated for AEFs. Seven patients underwent open surgical repair, and nine, with anatomically suitable lesions, underwent endovascular repair. The outcome after treatment of these patients was investigated for survival, perioperative complications, length of hospital stay, and long-term disposition.**
Results: **Three primary and 13 secondary AEFs were treated. The mean time from the initial aortic operation until AEF diagnosis was 5.9 years (range, 0.7-12.2 years) for patients with secondary AEFs. The overall 30-day mortality rate was 18.8%. One intraoperative death and one in-hospital death secondary to multisystem organ failure occurred in patients undergoing open repair. One in-hospital death related to persistent sepsis occurred in the endovascular group. The overall perioperative complication rate was 50.0%. Complications in the open group included sepsis, renal failure, bowel obstruction, and pancreatitis. Complications in the endovascular group were related to persistent sepsis. The mean in-hospital length of stay was significantly longer for patients undergoing open repair compared with endovascular repair (44.0 vs 19.4 days; $P = .04$). Four (80%) of five patients who were discharged from the hospital in the open group were placed in skilled nursing facilities, and seven (87.5%) of eight patients discharged in the endovascular group returned home. The median overall survival after hospital discharge was 23.1 months. There were no late aneurysm-related deaths or late deaths related to septic complications.**
Conclusions: **Patients with AEFs have limited overall survival. Endovascular therapy offers an alternative to open surgical repair, seems to be associated with decreased perioperative morbidity and mortality and a shorter in-hospital stay, and allows for acceptable survival given the presence of coexisting medical comorbidities. Furthermore, endovascular repair provides a therapeutic option to control bleeding and allow for continued intervention in a stabilized setting. (J Vasc Surg 2006;44:250-7.)**

Aortoenteric fistula (AEF) is one of the most challenging diagnostic and therapeutic entities in vascular surgery. Primary AEFs have a reported incidence of 0.04% to 0.07%,[1,2] whereas the development of secondary AEFs complicates 0.36% to 1.6% of all aortic operations.[3-6] Although the overall incidence of AEF seems to be decreasing and the diagnostic delays are shorter than they were historically,[7] morbidity and mortality after repairs remain high. Furthermore, the recently observed entity of AEF development after endovascular aortic repair has emerged as an additional causative factor.[8-12]

Traditional treatment of AEF has consisted of graft excision and extra-anatomic bypass. Alternatives to this have included in situ graft replacement and simple graft excision alone. Since its inception, endovascular repair has offered a less invasive alternative for the management of aortic disease, including limited reports for the treatment of AEF. We reviewed our experience with AEF over a 9-year period, since the initiation of endovascular aortic repair at our institution, and compared outcomes of patients treated with open and endovascular repair.

PATIENTS AND METHODS

Demographics. Over a 9-year period between January 1997 and January 2006, 16 patients underwent repair of AEFs at our institution, including 11 patients with secondary infrarenal AEFs. Of these 16 patients, 9 underwent endovascular repair, and 7 underwent open repair. These patients were identified through a search of a prospective endovascular database and a review of medical records based on diagnoses and procedures related to AEF. From this search, no patient was identified who had been diagnosed with an AEF and did not undergo any therapy. Medical records of all patients were investigated for patient demographics and comorbidities, details of previous aortic operations, clinical presentations of AEFs, methods of diagnosis, operative details, perioperative complications, lengths of hospital stay, and long-term dispositions. Differences in patient demographics and outcomes between those who were treated with open repair and those treated with endovascular repair were analyzed by either Fisher exact test or *t*-test analyses.

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Table I. Patient demographics and preoperative laboratory values

Variable	*Open (n = 7)*	*Endovascular (n = 9)*	*Total (n = 16)*
Mean age (y)	66.3	78.6	73.2
Male/female	5/2	6/3	11/5
Comorbidities			
CAD	3 (42.9)	8 (88.9)	11 (68.8)
COPD	2 (28.6)	6 (66.7)	8 (50.0)
CVA	2 (28.6)	3 (37.5)	5 (31.3)
Hypercholesterolemia	5 (71.4)	5 (55.6)	10 (62.5)
HTN	5 (71.4)	7 (77.8)	12 (75.0)
DM	2 (28.6)	1 (12.5)	3 (18.8)
Malignancy	3 (42.9)	3 (37.5)	6 (37.5)
Preoperative laboratory values			
Mean WBC ($\times 10^3/\mu L$)	12.6	11.6	12.1
Mean hematocrit	31.0%	29.3%	30.1%

CAD, Coronary artery disease; *COPD,* chronic obstructive pulmonary disease; *CVA,* cerebrovascular accident; *HTN,* hypertension; *DM,* diabetes mellitus; *WBC,* white blood cell count.

Clinical presentation and diagnosis. Anatomic locations of aortic fistulas in the open group included the esophagus (n = 1), stomach (n = 1), and duodenum (n = 5), and in the endovascular group they were located in the esophagus (n = 2), duodenum (n = 5), jejunum (n = 1), and sigmoid colon (n = 1). For AEFs of all locations, the mean age of patients undergoing endovascular repair was significantly older than the mean age of patients undergoing open repair (78.6 years [range, 65-91 years] vs 66.3 years [range, 54-80 years]; $P = .03$). For patients with secondary infrarenal AEFs, those undergoing endovascular repair were older than those undergoing open repair, although this difference did not reach statistical significance (78.8 vs 68.1 years; $P = .13$). Overall, the entire endovascular group had a mean of 3.7 comorbidities per patient, whereas the entire open group had a mean of 3.1 comorbidities per patient. Patients with secondary infrarenal AEFs were similar in terms of comorbidities, with 3.7 per patient in the endovascular group and 3.8 per patient in the open group (Table I).

For the eight patients in the endovascular group with secondary AEFs, all underwent their initial aortic operation for aneurysmal disease (Table II). Four of these eight patients underwent emergent aneurysm repairs for rupture. Of the five patients in the open group with secondary AEFs, four patients underwent their initial aortic operation for aneurysmal disease, and one patient underwent aortic surgery for occlusive disease. The patient who underwent his initial operation for occlusive disease, an end-to-end aortobifemoral bypass, required a revision secondary to limb thrombosis of his graft. One patient developed a secondary AEF after endovascular aortic repair with a device that has transrenal bare stents but lacks hooks or any other sharp fixation component. The mean interval from the time of initial aortic surgery until the time of presentation of AEF for the entire cohort was 5.9 years (range, 0.7-12.2 years). In patients undergoing open repair, the mean interval was 3.2 years (range, 0.7-8.7 years), and in patients undergoing endovascular repair, the mean interval was 7.4 years (range, 2.6-12.2 years).

Both patients in the open group with primary AEFs had a history of esophageal carcinoma. One patient was treated with preoperative chemoradiation before undergoing an esophagogastrectomy 2 months before his presentation. The second patient was also treated with chemoradiation but was deemed to have unresectable disease and underwent insertion of an esophageal stent 2 months before his presentation. The patient in the endovascular group with a primary fistula did not have any known gastrointestinal disease but did have a large (8-cm) abdominal aortic aneurysm.

Fourteen (87.5%) of the 16 patients presented with overt gastrointestinal bleeding in the form of either hematemesis or melena. Four of these patients, including two in the endovascular and two in the open group, presented with massive gastrointestinal bleeding and associated hemodynamic instability. Two patients presented with abdominal pain and had evidence of gastrointestinal bleeding on fecal occult blood testing and laboratory studies. Twelve of the 16 patients initially presented to outside institutions and were treated for a mean of 3.1 days (range, 1-13 days) before admission at our institution. Two of these patients had multiple hospital visits over the preceding months for gastrointestinal bleeding. No patient died while awaiting transfer or during the transfer process itself.

All patients in the endovascular group underwent esophagogastroduodenoscopy (EGD) and computed tomography (CT) scanning before repair. Additionally, two patients in this group had angiograms performed. In the open group, all patients underwent EGD, and five patients had CT scans before repair. Similarly, two patients in this group had angiograms performed, and a single patient underwent a radionuclide white blood cell scan. In both groups, angiograms were performed to determine the source of bleeding in cases that were unclear and not specifically to clarify anatomy for operative planning. Overall, EGD findings consistent with AEF, including active bleeding, ulceration, fistula tract, or visible graft, were seen in 10 (62.5%) of 16 patients. Three patients had a visible graft, and the remaining seven had one or more of the aforementioned findings at an anatomic location that was consistent with the diagnosis of AEF. For select patients, including those with esophageal cancer and primary AEFs, EGD findings were indicative of AEF, but the diagnosis was not confirmed until the time of operation. Of the 14 patients who had CT scanning, 12 (85.7%) had abnormalities indicative of AEF, including loss of the fat plane between the intestine and the aorta, air or fluid around the aorta, or direct communication between the intestinal lumen and the aorta (Fig 1). Of the four patients who underwent angiography, none had active bleeding to provide definitive evidence of AEF. Two patients underwent operation as a result of continued gastrointestinal bleeding with the presumed diagnosis of AEF despite inconclusive CT and endoscopic findings.

Table II. Characteristics of aortoenteric fistulas

Patient no.	*Location*	*Type*	*Previous aortic surgery*	*Interval from previous aortic surgery (y)*	*Positive perioperative blood culture*
Open group					
1	Aortoesophageal	1°	None	N/A	None
2	Aortogastric	1°	None	N/A	*Staphylococcus aureus*
3	Aortoduodenal	2°	Endovascular AAA repair	0.7	*Staphylococcus aureus, Enterobacter cloacae*
4	Aortoduodenal	2°	Open AAA repair	2.8	*Staphylococcus hominis*
5	Aortoduodenal	2°	Aortobifemoral bypass	8.7	*Enterobacter cloacae, Enterobacter faecium*
6	Aortoduodenal	2°	Open AAA repair	3.0	*Enterobacter cloacae*
7	Aortoduodenal	2°	Open AAA repair	2.9	*Streptococcus milleri*
Endovascular group					
1	Aortoesophageal	2°	Open TAA repair	5.2	*Klebsiella pneumoniae*
2	Aortoesophageal	2°	Open ThAA repair	6.9	*Aspergillus fumigatus*
3	Aortoduodenal	2°	Open AAA repair	12.2	None
4	Aortoduodenal	1°	None	N/A	None
5	Aortoduodenal	2°	Open AAA repair	6.1	*Streptococcus salivarius, Pseudomonas aeruginosa*
6	Aortoduodenal	2°	Open AAA repair (rupture)	2.6	None
7	Aortoduodenal	2°	Open AAA repair (rupture)	12.1	None
8	Aortojejunal	2°	Open AAA repair (rupture)	5.0	None
9	Aortosigmoid	2°	Open AAA repair (rupture)	9.0	*Enterobacter cloacae*

AAA, Abdominal aortic aneurysm; *TAA,* thoracic aortic aneurysm; *ThAA,* thoracoabdominal aortic aneurysm; *1°,* primary; *2°,* secondary; N/A, not applicable.

Perioperative management and procedures. All patients were started on broad-spectrum intravenous antibiotics before surgery once the diagnosis of AEF was made. All patients who underwent endovascular repair were determined to be at high risk for open repair and had lesions that were anatomically suitable on the basis of preoperative CT angiography, including the presence of an adequate proximal neck and access vessels that were of appropriate size and limited tortuosity to allow for passage of endovascular devices.

The devices that were used for endovascular repair included custom-made Parodi (Johnson and Johnson, Sommerville, NJ)/Palmaz (Impra, C. R. Bard, Murray Hill, NJ) aortouni-iliac devices in three patients, Talent (Medtronic, Minneapolis, Minn) tube grafts in two patients, a Talent bifurcated graft in one patient, the bifurcated Gore Excluder (W. L. Gore, Flagstaff, Ariz) in two patients, and the Gore TAG thoracic device in one patient. The endovascular procedures were all performed in the operating room with patients prepared and draped in preparation for possible conversion to open repair. Anesthesia for these nine cases included general endotracheal anesthesia for four patients, epidural anesthesia for three patients, and local anesthesia with lidocaine in two patients. Stent-graft placement of infrarenal aortic devices was performed via bilateral femoral artery cutdowns under C-arm fluoroscopic guidance. Placement of thoracic aortic devices was performed via unilateral femoral artery cutdown and percutaneous access of the contralateral femoral artery. Patients who were clinically well without evidence of ongoing blood loss and without evidence of sepsis were started on oral feeding on postoperative day 1. Select patients with decreasing hematocrits underwent postoperative endoscopic evaluation to confirm cessation of AEF bleeding. All patients were placed on lifelong suppressive oral antibiotics after their endovascular repairs; these were organism specific in the setting of positive perioperative cultures. Follow-up CT scans were obtained at 1, 6, and 12 months and annually thereafter, in accordance with our protocol for patients who undergo endovascular repair of aneurysmal disease (Fig 2).

Of the seven patients who underwent open repair, four underwent axillary-bifemoral bypass before graft excision and fistula repair. Three of these were performed immediately before repair, and one was staged 3 days before definitive repair. Additionally, one patient underwent axillary-bifemoral bypass after graft excision and fistula repair. The patient with the aortogastric fistula underwent primary aortic repair without extra-anatomic bypass, and the patient with the aortoesophageal fistula underwent attempted primary aortic repair as well. Of the five patients who underwent open repair of secondary AEFs, two required suprarenal clamping to obtain aortic control, whereas three required supraceliac clamping. Retrospectively, the two patients who required suprarenal clamping may have had anatomy that was suitable for endovascular treatment, but these patients were deemed fit for open repair and were determined to have less than ideal anatomy for endovascular repair on the basis of their preoperative imaging. Open repair included wide drainage and, when possible, placement of omentum in the aortic graft bed. Intestinal repair consisted of debridement and primary closure for four patients, resection with anastomosis for one patient, and resection with diversion for one patient.

RESULTS

Perioperative adverse events. The overall 30-day mortality rate was 18.8% (3/16), including 2 deaths in the open

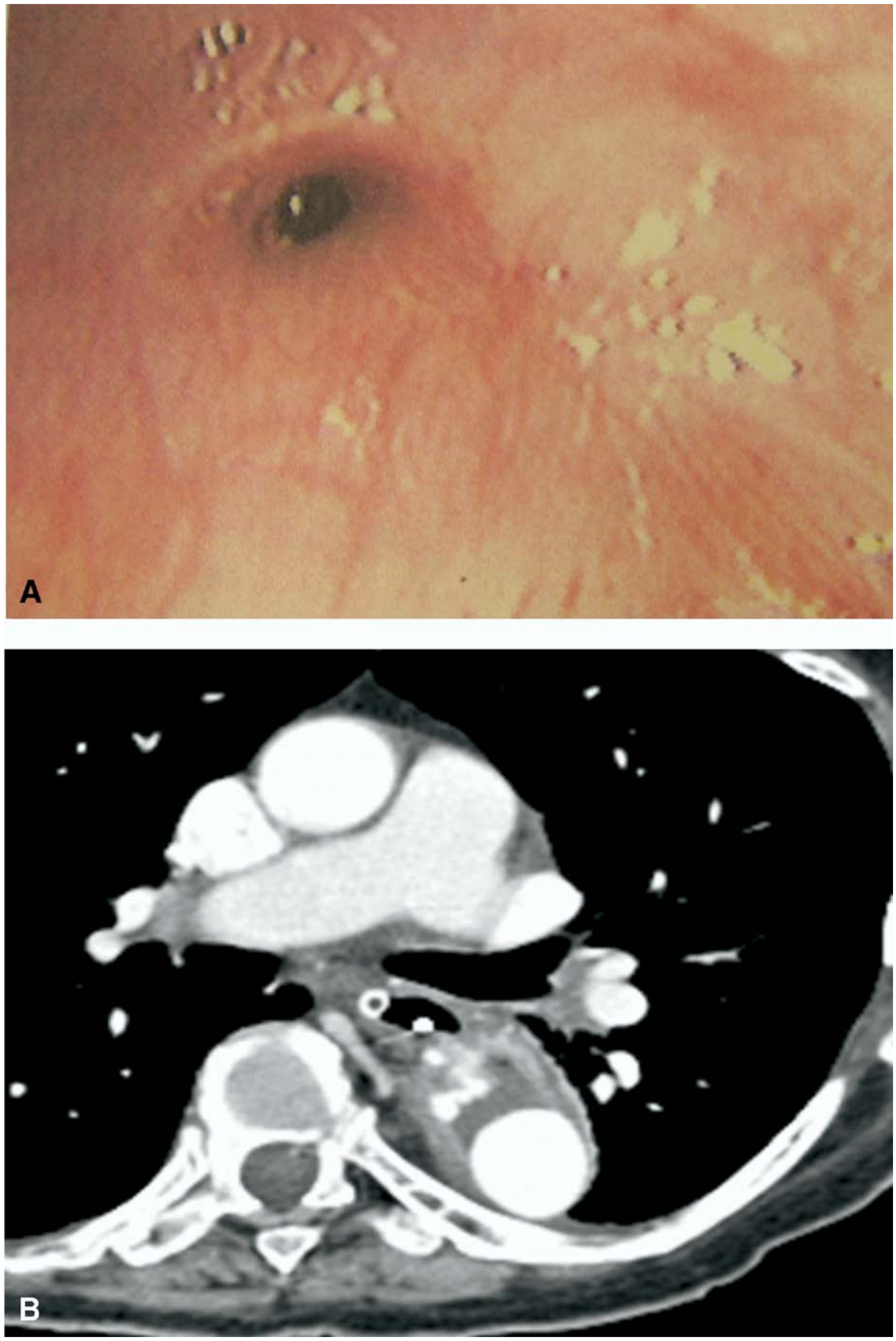

Fig 1. A, Endoscopic image demonstrating an aortoesophageal fistula tract in a patient who presented with hematemesis and had undergone open thoracic aortic aneurysm repair 5 years previously. **B,** Computed tomographic scan of the same patient demonstrating fluid collection around the aorta and contrast extravasation. The radiodense object in the esophageal lumen is a metallic clip placed at the time of endoscopy.

group and 1 death in the endovascular group. There was one intraoperative death in the open group from cardiopulmonary arrest due to uncontrolled hemorrhage and one death 14 days after surgery from persistent sepsis. The death in the endovascular group was due to fungal sepsis after repair of an aortoesophageal fistula. The 30-day mortality rate for patients with secondary infrarenal AEF was 9.1% (1/11), which occurred, as above, as a result of persistent sepsis in a patient with an aortoduodenal fistula who presented with massive gastrointestinal bleeding ne-

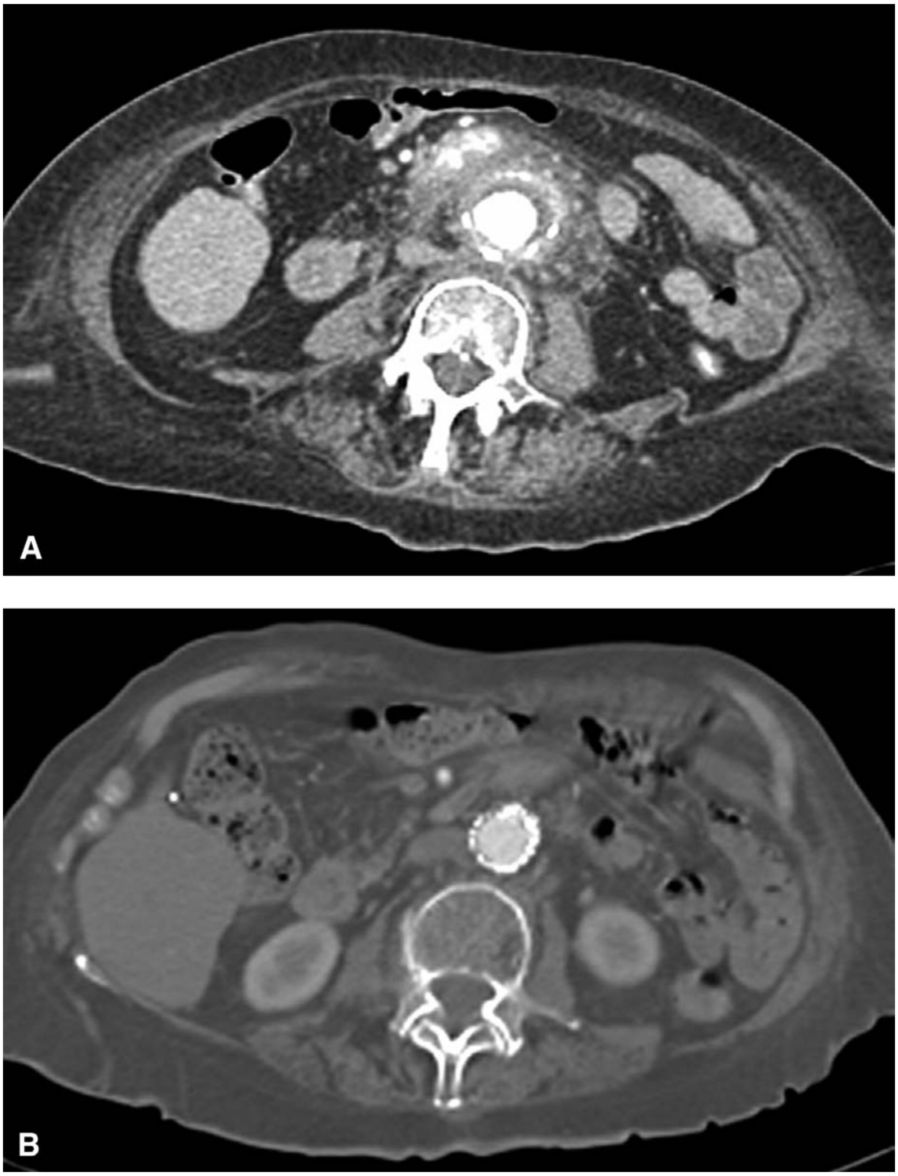

Fig 2. A, Computed tomographic scan performed only with intravenous contrast demonstrating inflammatory changes around the aorta and contrast within the intestinal lumen. **B,** Computed tomographic angiography 12 months after successful endovascular repair.

cessitating immediate aortic repair followed by axillary-bifemoral bypass.

Overall, perioperative complications occurred in 8 (50%) of 16 patients (Table III). In the open group, these consisted of acute renal failure necessitating hemodialysis, bowel obstruction necessitating exploratory laparotomy and lysis of adhesions, mediastinal abscess necessitating multiple operative drainages, multisystem organ failure, and pancreatitis. Complications in the endovascular group were related to persistent sepsis in three patients, and this led to multisystem organ failure in one patient. Perioperative complications occurred in 6 (54.5%) of 11 patients undergoing repair of a secondary infrarenal AEFs, including 4 (80.0%) of 5 in the open group and 2 (33.3%) of 6 in the endovascular group. The first complication in the endovascular group occurred in a patient with an aortosigmoid fistula who developed a retroperitoneal abscess necessitating drainage and a diverting ileostomy on postoperative day 2. He subsequently underwent a Hartmann procedure on postoperative day 8. A second patient with a large perigraft collection from an aortoduodenal fistula underwent percutaneous CT-guided drainage for persistent sepsis after stent-graft placement.

Table III. Perioperative complications and disposition

Patient no.	*Perioperative complications*	*Length of stay (d)*	*Disposition*	*Survival after discharge (mo)*
Open group				
1	Intraoperative death	1	In-hospital death	N/A*
2	Mediastinal abscess	78	Extended care facility	Alive at 33
3	Bowel obstruction	50	Extended care facility	47
4	Acute renal failure	45	Extended care facility	26
5	Pancreatitis	28	Home	49
6	Multisystem organ failure	14	In-hospital death	N/A
7	None	19	Extended care facility	1
Endovascular group				
1	None	10	Extended care facility	Alive at 1
2	Multisystem organ failure	17	In-hospital death	N/A
3	None	13	Home with visiting nurse services	Alive at 18
4	None	7	Home	27
5	Persistent sepsis	32	Home	10
6	None	2	Home	5
7	None	32	Home	40
8	None	5	Home	3
9	Persistent sepsis	54	Home with visiting nurse services	15

*N/A, not applicable

Length of stay and discharge disposition. The mean overall length of stay for patients who were successfully discharged from the hospital was 28.8 days. The mean length of stay was significantly longer in the open group compared with the endovascular group (44.0 vs 19.4 days; $P = .04$). For patients undergoing repair of a secondary infrarenal AEF, there was a trend toward a longer mean length of stay in the open group compared with the endovascular group (35.5 vs 23.0 days; $P = .32$). Overall, in the open group, four of five discharged patients were placed in skilled nursing facilities. In the endovascular group, seven of eight discharged patients returned home, although two required temporary visiting nurse services. After repair of secondary infrarenal AEFs, three of four patients in the open group were placed in skilled nursing facilities, whereas all six discharged patients in the endovascular group returned home.

Late complications and mortality. There were two late infectious-related complications in the endovascular group, both after repair of secondary infrarenal AEFs. One patient was hospitalized twice, 2 and 6 months after his repair, for bacteremic episodes, which were both treated with intravenous antibiotics. CT scans were obtained at each hospitalization and failed to demonstrate any intra-abdominal fluid collections. A second patient developed a pseudoaneurysm at the distal anastomosis of a prosthetic femoral artery interposition graft that had been placed at the time of stent-graft deployment because of arterial damage. This was successfully managed with graft excision and replacement with an autologous vein graft 14 months after her AEF repair. There were no late amputations, embolic events, or graft thromboses in either group.

The median overall survival after hospital discharge was 23.1 months (range, 1-49 months). Median survival in the open group was 38.0 months, compared with 12.3 months in the endovascular group ($P = .10$). Of patients undergoing repair of a secondary infrarenal AEF, the median overall survival in the open group was 36.5 months, compared with 12.3 months in the endovascular group ($P = .23$). Overall, there were four late deaths in the entire open group: three from unknown causes and one from lung cancer. There were six late deaths in the entire endovascular group: three from myocardial infarctions, one from a pulmonary embolism, one from a cerebrovascular accident, and one from metastatic breast cancer.

DISCUSSION

Although AEFs are relatively rare, they continue to be a morbid and often mortal complication of aortic aneurysms. The exact pathogenesis of the development of AEF has not been fully elucidated, but both mechanical erosion and infection are thought to play a role.[3,5,13,14] Furthermore, recently there have been multiple reports of AEFs developing after endovascular aortic repair, despite the theoretical lack of extraluminal disruption.[8-12] Regardless of etiology, the traditional management goals of AEF have been to control hemorrhage, to control infection, and to maintain adequate distal perfusion: these have been achieved through graft excision and extra-anatomic bypass. In recent years, endovascular repair has emerged as another therapeutic option, particularly for the rapid control of bleeding from AEF.

Despite technological advances, the cornerstone of diagnosing AEF continues to be clinical suspicion. Initial bleeding is usually minor and is often self-limited, and this may lead to a delay in definitive diagnosis. Additionally, the time from the "herald bleed" to massive rebleeding may be hours to months. This delay was seen in our series, in which 12 of 16 patients initially presented to outside institutions and were hospitalized for a mean of 3.1 days before transfer. Furthermore, bleeding may result from direct communication between an aortic anastomosis and the intestinal lumen or from graft erosion into the intestinal wall leading to hemorrhage from the intestinal wall edges. For the latter scenario, endovascular repair is less likely to be effective in controlling blood loss than open repair.

CT scanning has been advocated as the preferred initial diagnostic test for patients with AEF, with a reported sensitivity of up to 93%.[15,16] In our series, there was an 85.7% sensitivity (12 of 14 patients who underwent CT scanning) in detecting AEF. EGD has less sensitivity than CT scanning, with reported findings in 25% to 80%,[1,3,5,7] similar to the sensitivity of 62.5% in our patients. EGD should be performed by an experienced endoscopist and may require a pediatric colonoscope to appropriately evaluate the entire duodenum. Additionally, colonoscopy may be useful in patients who present with gastrointestinal bleeding, previous aortic repair, and a negative EGD, given the possibility of aortocolonic fistulization, as in one patient in our series. Angiography should be reserved for patients in whom the diagnosis of AEF is unclear to help determine a source of bleeding.

For stable patients with minimal comorbidities and significant life expectancies, surgical management of AEF via staged extra-anatomic bypass followed by graft excision is optimal because it provides definitive management, limits lower extremity ischemia, and allows for patient recovery between operations. This has been shown to be relatively safe, but it is still associated with a significant mortality of up to 27%.[5,17] Simultaneous repair of extra-anatomic bypass followed immediately by graft excision is an acceptable alternative that has also been shown to be feasible, with acceptable morbidity and mortality.[3,15] Additional surgical options include graft excision alone, graft excision with in situ replacement, and primary repair, all of which should be reserved for select patients.[18] Management of the intestinal portion of fistulas has been demonstrated to have acceptable outcomes with simple bowel repair, although resection may be necessary for certain patients.[19]

Patients with AEFs who present with shock, require preoperative transfusions, and need suprarenal aortic control during repair have a higher associated early mortality.[15] Furthermore, patients with AEFs often have multiple comorbidities and limited life expectancies that may place them at high risk for open repair. Endovascular aortic repair offers patients in these populations a less invasive alternative to seal the fistula and control bleeding.[20-24] However, unlike open repair with graft excision, the likely-infected graft and/or aorta remains in situ, and this places the newly implanted stent graft at risk for infection. A variety of adjunctive therapies have been used to both rapidly control hemorrhage and decrease the risk of persistent infection, including fibrin sealant instillation into a fistula tract[25] and the injection of *n*-butyl 2-cyanoacrylate into a fistula tract,[26] both followed by stent-graft placement. Although these techniques may help, endovascular repair is limited because it does not include intestinal repair. On the basis of our experience, select patients may heal their AEFs after endovascular repair coupled with antibiotic therapy, particularly those with secondary infrarenal AEFs who present without evidence of sepsis. However, for patients with AEFs involving the esophagus or the colon who undergo endovascular repair, additional procedures should be included in most cases to decrease the risk of persistent sepsis. This may include open intestinal repair or simple diversion alone. For patients who present with overt sepsis and have prohibitive comorbidities to immediate open repair, endovascular repair, when coupled with percutaneous or even open drainage, may serve as a palliative measure. Additionally, for patients who may be medically optimized, endovascular repair may serve as a bridging therapy to open repair, particular if patients have ongoing sepsis or other infectious complications. In our series, two patients had persistent infectious complications after endovascular repair. The first patient, who had an aortosigmoid fistula, underwent two gastrointestinal procedures and was discharged home. He was later offered and refused any additional interventions and died 18 months after repair from a cerebrovascular accident. The second patient, who had an aortoduodenal fistula, was 88 years old and had unreconstructable coronary artery disease, chronic obstructive pulmonary disease, and renal insufficiency; was thought not to be a candidate for conversion; and died 11 months after repair from a myocardial infarction.

In our series, the overall endovascular group, as well as those who underwent endovascular repair of secondary infrarenal AEFs, had a lower incidence of perioperative complications and a shorter length of hospital stay compared with those who underwent open repair. Furthermore, nearly all of the endovascular patients could be discharged home, whereas most patients who underwent open repair required placement in skilled nursing facilities. It is interesting to note that the median overall survival after discharge was longer in the open group, but this is most likely related to the number and severity of the comorbidities in the endovascular group, in addition to their significantly older age. Given these data, endovascular repair as a palliative procedure for select patients is valuable by allowing for relatively short hospital stays and discharge to home.

This study is limited by its retrospective nature and relatively small number of patients. Furthermore, patients who develop AEFs and undergo repair represent a diverse spectrum of general medical conditions. Although comparisons between the two groups have been made, the modality for treatment for each patient was individualized on the basis of anatomy, underlying medical comorbidities, and, to some extent, expected long-term survival. Overall, patients undergoing endovascular repair in this series tended to represent a more morbid cohort with a shorter life expectancy, and this must be considered when the data are interpreted.

CONCLUSION

AEFs remain an often fatal complication of aortic repair. Despite advances in imaging and endoscopic technology, diagnostic dilemmas have continued. Conventional open repair continues to be associated with significant perioperative morbidity and mortality rates and lengthy hospitalizations. Endovascular repair, which seems to be associated with decreased perioperative morbidity and mortality and a shorter in-hospital stay, provides an alternative therapeutic option to control bleeding and allow for continued intervention in a stabilized setting. Patients with overt sepsis or AEFs involving the esophagus or colon and prohibitive comorbidities to open repair may be candidates for endovascular repair but should also undergo drainage, intestinal repair, or diversion to minimize the risk of ongoing infectious complications. Furthermore, for patients with multiple comorbidities and limited life expectancies, endovascular repair coupled with lifelong suppressive antibiotic therapy may allow for freedom from further complications related to the AEF.

AUTHOR CONTRIBUTIONS

Conception and design: DTB, AC, MLM
Analysis and interpretation: DTB, AC, SHE, US, TSJ
Data collection: DTB, EP
Writing the article: DTB, AC
Critical revision of the article: AC, SHE, EP, US, TSJ, MLM
Final approval of the article: DTB, AC, SHE, EP, US, TSJ, MLM
Statistical analysis: DTB, US
Obtained funding: MLM
Overall responsibility: DTB

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