



## Outcomes for Endovascular Repair of Infected Abdominal Aortic Aneurysms

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### Abstract

**Aim:** We have reviewed our ruptured and non-ruptured infected Abdominal Aortic Aneurysms (AAA) to study the clinical presentation, management and eventual outcome of patients managed with endovascular repair.

**Design:** A prospective study and analysis of 9 cases treated at a single institution.

**Methods:** From January 2009 to December 2011, a total of 9 patients with infected AAA underwent Endovascular Aneurysmal Repair (EVAR) at our institution. Six patients were male and 3 were female with the mean age of 67 years (range, 57–83). The diagnosis of infected AAA was determined by clinical evidence of infection (pain, fever and leukocytosis), aortic image, and positive results from blood cultures, pus culture (from CT guide percutaneous and surgical drainage) and Polymerase Chain Reaction (PCR). Empirical parenteral antibiotics were administered on admission. At the time of an operation, all were saccular and 4 of the 9 aneurysms (44.4%) were ruptured (3 contained, 1 free ruptured). All patients have undergone EVAR for AAA; 5 used Bifurcated stent grafts, 2 Tube stent grafts and 2 Aorto-uniiliac stent grafts with femoro-femoral bypass grafting. The parenteral antibiotics were continued in the postoperative period for 4-6 weeks.

**Results:** Chronic Renal Disease (CRD) was present in 66.66% (6/9), Coronary Heart Disease (CHD) was present in 55.55% (5/9), Chronic Pulmonary Obstructive Disease (COPD) present in 44.44% (4/9) with diabetes mellitus present in 22.22% (2/9). The most common pathogen was Salmonella species (n=5), Escherichia coli (n=2) and B. pseudomallei (n=2). Forty-four percent (4/9) of the patients presented with ruptured that needed an emergency surgery. There was no 30 days mortality and significant morbidity. Three patients (patient no. 1, 5 and 7) had Infected Stent Grafts (ISG) at 10, 26 and 36 months after EVAR, subsequently received CT-guided percutaneous tube drainage and 2 patients (patient no. 1 and 5) needed later stent graft explantation. One patient (patient no. 7) refused stent graft explantation and died 1 month later at another hospital from gastrointestinal bleeding and septicemia.

**Conclusions:** The immediate results of EVAR for Infected AAA are fair with no 30 days mortality and few complications. The midterm results are not satisfied due to high rate of Infected Stent Grafts (ISG) 33.33% (3/9). EVAR is not a definitive treatment of Infected AAA; it could be a temporizing treatment prior to definitive open surgical repair, or a therapeutic alternative in critically ill patients who may not survive open surgery.

**Keywords:** Infected stent grafts, infected abdominal aortic aneurysm, endovascular treatment

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### Introduction

Management of infected AAA is a challenging and difficult clinical problem for the vascular surgeon. In the West, Infected AAA is rare; they represent only 1% to 2% of all aortic aneurysms [1]. In an Asian population, infected AAA may raise up to 13.6% [2]. Infected AAA are associated with high morbidity and high mortality 21-44% because they are frequently associated with complicating factors, such as late or delay in diagnosis, rupture, sepsis, and comorbid diseases of the patients [1,2]. The gold standard for treatment of infected AAA is aggressive surgical resection, debridement of infected periaortic tissues, and reconstruction of the aortic flow by anatomic or extra-anatomic techniques. However; the presence of unfavorable anatomy, a hostile operative field after previous surgery, a contained rupture, or a physiologically debilitated state can elevate operative risk and morbid level [3-5]. In this report, we describe our experience with the management of 9 patients with infected AAA of the infra renal, all patients underwent endovascular repair.

**Table 1:** Patient demographics.

Case	Age/Gender	Pathogens	Diagnosis	Underling diseases	Rupture
1	71/M	Salmonella	Hemoculture/Pus culture	COPD/CHD/HT	No
2	69/M	B.pseudomallei	Hemoculture/PCR	Beta-thalasemia/HT	No
3	72/M	E.coli	Hemoculture/Pus culture	Bronchiectasis/CHD	No
4	83/F	Salmonella	Hemoculture	CKD/COPD	No
5	57/M	B.pseudomallei	Hemoculture/PCR	CKD/CHD/ DM	No
6	75/F	Salmonella	Hemoculture	CKD/CHD/ COPD	Yes
7	58/M	E.coli	Hemoculture/Pus culture	CKD/Gouty arthritis	Yes
8	81/M	Salmonella	Hemoculture	CKD/COPD/ HT	Yes
9	61/F	Salmonella	Hemoculture	CKD/CHD/ DM	Yes

COPD: Chronic Obstructive Pulmonary Disease; CHD: Coronary Heart Disease; HT: Hypertension; CKD: Chronic Kidney Disease; DM: Diabetes Mellitus, PCR: Polymerase Chain Reaction

## Case Presentation

During the study period from January 2009 to December 1 2011, nine patients (six men, three women) with primary infected infrarenal AAA were treated using this EVAR strategy. Patients were a mean age of 67 years (range, 57–83 years). All patients had positive blood cultures showing five *Salmonella*, two *Escherichia coli*, and two *B. pseudomallei*. Broad-spectrum antibiotics were used in all 9 patients. Mean C-reactive protein level was 188 mg/L (range, 67 mg/L to 486 mg/L) and mean white blood cell (WBC) was 11 (range, 8–18 x 10<sup>9</sup>/L). The diagnosis of aortic aneurysm was confirmed by abdominal CT scan and by CT angiography. All of the patients had aortic pseudoaneurysms with a mean size of 5.2 cm (range, 4.3 cm to 7.2 cm). There was no 30 days mortality. After 4 weeks of intravenous antibiotics postoperatively, lifelong oral antibiotics were maintained, if possible. All patients were followed in an outpatient clinic at 1, 6, and 12 months and thereafter once a year. The mean follow-up period was 74 months (range, 54–81 months). Three patients had Infected Stent Grafts (ISG) at 10, 26 and 36 months after EVAR, subsequently received CT-guided percutaneous tube drainage and needed later stent graft explantation. Patient no. 1 underwent axillo-bifemoral bypass grafting and stent graft explantation. Patient no. 2 underwent stent graft explantation and In-situ Dacron graft interposition. Patient no. 3 refused stent graft explantation and died 1 month later at another hospital from gastrointestinal bleeding and septicemia (Table 1). All nine patients consented to publication of this report.

### Patient 1

A 71-year-old man with a past history of arterial hypertension, chronic smoking, and myocardial infarction underwent elective EVAR for primary Infected AAA using a Cook Zenith Endograft for the main body TFFB-23-111-2T; legs TFLE-15-78-2T and TFLE-16-62-2T. (Cook Medical, Bloomington, IN). The patient had a history of positive hemocultures with *Salmonella*. Ten months after, he presented with back pain, asthenia, anorexia, 5 kg weight loss, and fever in the last 7 days. On physical examination, the abdomen was tender in the epigastric area to deep palpation. His blood results showed an elevated white blood cell count to 16 x 10<sup>9</sup>/L with 75% of neutrophils and anemia of 7.5 g/dL. A CT scan revealed the stent graft surrounded by an abscess with air. CT guided percutaneous drainage was performed and yielded 30 cc pus with positive culture of *Salmonella*. The patient underwent an elective operation. First, a right-sided axillofemoral bypass was performed, employing an 8 mm PTFE prosthesis. Through a midline laparotomy the endograft was completely removed (Figure1-3). The infrarenal aorta and left

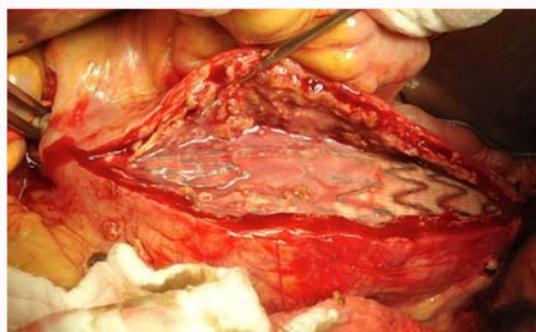


Figure 1: Infected endograft with purulentpus after aneurysm sac opening.



Figure 2: Explantation of Infected Endograft.



Figure 3: Explanted Infected Endograft.

common iliac artery were closed using nonabsorbable sutures and covered with omentum. Debridement of the abscess and lavage of the cavity were performed. *Salmonella* grew in the endograft culture. Hemocultures, microbiological cultures of aortic tissue and the

**Table 2:** Treatment Procedures and Results.

Case	Procedures	Complications	Second Procedure	Third Procedure	Follow up (months)/ Status
1	Bifurcated Graft	Infected Stent Graft 10 months after EVAR	CT guided percutaneous drainage	AFB/Explantation 1 month after drainage	64/ Alive
2	AUI Graft/AFB	No	No	No	81/Alive
3	Bifurcated Graft	No	Surgical Drainage	No	79/Alive
4	Tube Graft	No	No	No	82/Alive
5	Bifurcated Graft	Infected Stent Graft 36 months after EVAR	CT guided percutaneous drainage	Explantation/In situ Dacron Graft Interposition 6 months after drainage	57/ Alive
6	Bifurcated Graft	Left Graft Limb Occlusion	Thromboembolectomy	No	80/Alive
7	Bifurcated Graft	Infected Stent Graft 26 months after EVAR	CT guided percutaneous drainage	No, refused an operation	Dead 1 month later from sepsis and gastrointestinal bleeding
8	AUI Graft/AFB	No	No	No	76/Alive
9	Tube Graft	No	No	No	77/Alive

AUI: Aortouniiliac; AFB: Axillobifemoral Bypass; EVAR: Endovascular Aneurysmal Repair

**Table 3:** Patients with Infected Stent Grafts (ISG).

Case	Age/ Gender	Pathogens	Endografts	Interval, (months)	Second Procedure	Third Procedure	Follow-up(months)/Result
1	71/M	Salmonella	Zenith	10	CT guided percutaneous drainage	Explant+AFB 1 month after drainage	64/ Alive
2	57/M	B.pseudomallei	AneuRX	36	CT guided percutaneous drainage	Explant+In situ Dacron Graft Interposition 6 months after drainage	57/ Alive
3	58/M	E.coli	Zenith	26	CT guided percutaneous drainage	No, refused an operation	Dead 1 month later from Sepsis and Gastrointestinal bleeding

AFB: Axillo-Bifemoral Bypass

abscess were negative. The patient received empirical intravenous antibiotics during 6 weeks of hospitalization. The postoperative course was uneventful, and the patient was discharged in good clinical conditions. Twenty-four months after surgery, both the clinical syndrome and CT scan showed no evidence of recurrent infection.

## Patient 2

A 57-year-old man with a past history of chronic kidney disease, chronic smoking, and diabetes mellitus underwent elective EVAR for primary Infected AAA using an AneuRx for the main body 28 mm: legs 16 and 15 mm. (Medtronic, Inc., Minneapolis, MN). The patient had a history of positive hemocultures with *B. pseudomallei*. Thirty-six months after, he presented with abdominal pain, anorexia, 3 kg weight loss, and fever in the last 10 days. On physical examination, the abdomen was tender in the epigastric area to deep palpation. His blood results showed an elevated white blood cell count to  $13 \times 10^9/L$  with 81% of neutrophils and anemia of 8.5 g/dL. A CT scan revealed the stent graft surrounded by an abscess with air. CT guided percutaneous drainage was performed and yielded 25 cc pus with negative culture for organism. The patient underwent an elective operation. Through a midline laparotomy the endograft was completely removed. Aortic reconstruction with *in situ* Dacron graft placement with aortobi-iliac graft configuration was performed and covered with omentum. Debridement of the abscess and lavage of the cavity were performed. Hemocultures, microbiological cultures of aortic tissue, endograft and the abscess were negative. The patient received empirical intravenous antibiotics during 6 weeks of hospitalization. The postoperative course was uneventful, and the patient was discharged in good clinical conditions. Twenty-four months after surgery, both the clinical syndrome and CT scan showed no evidence of recurrent infection.

## Patient 3

A 58-year-old man with a past history of chronic kidney disease and gouty arthritis underwent emergency EVAR for primary Infected

AAA using a Cook Zenith Endograft for the main body TFFB-30-111-2T: legs TFLE-10-88-2T and TFLE-18-56-2T. (Cook Medical, Bloomington, IN). The patient had a history of positive hemocultures with *E. coli*. Twenty-six months after, he presented with back pain, anorexia and high fever in the last 7 days. On physical examination, the abdomen was tender in the epigastric area to deep palpation. His blood results showed an elevated white blood cell count to  $15 \times 10^9/L$  with 83% of neutrophils and anemia of 8.1 g/dL. A CT scan revealed the stent graft surrounded by an abscess with air. CT guided percutaneous drainage was performed and yielded 15 cc pus with positive culture of *E. coli*. The patient refused stent graft explantation and died 1 month later at another hospital from aorto-enteric fistula with gastrointestinal bleeding and *E. coli* septicemia.

## Results

Between January 2009 and December 1 2011, 9 consecutive patients (six men, three women) with primary infected infrarenal AAA were treated using this EVAR strategy. Patients were a mean age of 67 years (range, 57–83 years). The demographic data and the pathogens are presented in Tables 1 and 2.

All of the patients presented with abdominal or back pain, and five had recurrent fevers. All patients had positive blood cultures, 3 patients had positive tissue cultures (33.33%) and 2 (22.22%) had positive Polymerase Chain Reaction (PCR). Broad-spectrum antibiotics were used in all 9 patients. Mean C-reactive protein level was 188 mg/L (range, 67 mg/L–486 mg/L) and mean White Blood Cell (WBC) was 11 (range,  $8 \times 10^9$ – $18 \times 10^9/L$ ). Chronic Renal Disease (CRD) was present in 66.66 % (6/9), Coronary Heart Disease (CHD) was present in 55.55 % (5/9), Chronic Pulmonary Obstructive Disease (COPD) present in 44.44% (4/9) with diabetes mellitus present in 22.22% (2/9). None of the 9 patients had evidence of immune deficiency. The diagnosis of aortic aneurysm was confirmed by abdominal CT scan and by CT angiography. All of the patients had aortic pseudoaneurysms with a mean size of 5.2 cm (range, 4.3

cm–7.2 cm).

Four patients had ruptured aneurysms; 3 had focal aortic pseudoaneurysms with contained ruptures (33.33%) and 1 free rupture with signs of hemodynamic instability (11.11%), all received urgency EVAR operations. Fever was present in two of the four urgency operative cases. Fever was controlled in most of the patients undergoing elective operations preoperatively. In addition to the typical infectious presentation and the imaging appearance on CT, all patients had positive blood culture reports showing five *Salmonella*, two *Escherichia coli*, and two *B. pseudomallei*. One patient (patient no. 6) developed left graft limb occlusion, which underwent successful thromboembolectomy; one (patient no. 3) underwent a minilaparotomy for open debridement due to persistent fever. There was no 30 days mortality. After 4 weeks of intravenous antibiotics postoperatively, lifelong oral antibiotics were maintained, if possible.

All patients were followed in an outpatient clinic at 1, 6, and 12 months and thereafter once a year. The mean follow-up period was 74 months (range, 54–81 months). Three patients (patient no. 1, 5 and 7) had Infected Stent Grafts (ISG) at 10, 26 and 36 months after EVAR, subsequently received CT-guided percutaneous tube drainage and needed later stent graft explantation (Table 3.). Patients with Infected Stent Grafts (ISG) Patient no. 1 underwent axillo-bifemoral bypass grafting and stent graft explantation. Patient no. 5 underwent stent graft explantation and In-situ Dacron graft interposition. Patient no. 7 refused stent graft explantation and died 1 month later at another hospital from gastrointestinal bleeding and septicemia.

## Discussion

Primary arterial infections have been classified into 4 types [1].

1. Mycotic aneurysm due to septic emboli (embolomycotic); usually from endocarditis.
2. Microbial arteritis–Bacteremia causes infection in an atheromatous plaque leading to destruction of the wall and aneurysm formation; this is most common in the aorta.
3. Infection of a pre-existing aneurysm.
4. Post traumatic false aneurysm, such as following penetrating injury, invasive intra-arterial cannulation or drug abuse.

There are several theories to explain the pathology of aortic infection. Infected microemboli may lodge in the aortic infection. Infected microemboli may lodge in the vasa vasorum causing occlusion and damage to the aortic wall, which leads to degeneration and aneurysm formation. Emboli can also lodge in the irregular intima or the thrombus in the aneurysm during bacteremia. Aortic wall infection can occur due to direct inoculation into the arterial wall. Organisms may colonize the intact vascular wall through the vasa vasorum, where a local suppurative process, which results in Microbial arteritis with aneurysm formation, weakens the arterial wall [6-8].

With the introduction of antibiotics during the past 50 years, the incidence of infective endocarditis decreased gradually, and infected aortic aneurysms associated with endocarditis became rare [9]. In nonendocarditis bacteremia or secondary to septic emboli, the most commonly reported site of infected aneurysms was the abdominal aorta due to infection of existing atherosclerotic plaque and aneurysms with a larger vasa vasorum, where infected emboli may dislodge. An interesting feature is that *Salmonella* spp., rather than

*Staphylococcus* spp., seem to cause most infected aortic aneurysms in Eastern countries. It may be plausible that people in Eastern countries eat foods which in general have a greater than average risk of contamination with *Salmonella* spp.

*Salmonella* species in particular have a strong predilection to infect damaged aortic intima and abnormal arterial intima, especially arteries harboring atherosclerotic plaque [7,10]. Characterization of the different bacteria is important, since gram-negative sepsis results in higher rupture rates than infection with gram-positive bacteria [10]. The virulence species, *Salmonella typhimurium* and *Salmonella choleraesuis*, account for over 50% of the reported cases of infected aneurysms [7,10]. Other common organisms are *Streptococcus*, *Bacteroides*, *Escherichia coli*, and *Staphylococcus aureus* [11]. In our report, *Salmonella* sp. was responsible in 55.55% (n =5) of patients (Table 1). *E. coli* 22.22% (n =2), and *Burkholderia pseudomallei* 22.22% (n =2). Gram-negative organisms were by far the most common isolates from hemocultures. *Salmonella* sp. responded in 66.66% (4/6) of patients and is thought to exhibit a more virulent course because of its ability to invade the normal intima and cause early aneurysm rupture [11].

The complicated early outcome in patients with infected aortic aneurysms probably reflects the combination of an aggressive presentation, high rupture rate, and complex aneurysm location in hosts with chronic comorbid conditions. This study shows 44.44% (4/9) incidence of aneurysm rupture. All of our patients had at least one chronic comorbid condition; Chronic Renal Disease (CRD) was present in 66.66 % (6/9), Coronary Heart Disease (CHD) was present in 55.55 % (5/9), Chronic Pulmonary Obstructive Disease (COPD) present in 44.44% (4/9) with diabetes mellitus present in 22.22% (2/9). Despite the fact that infected aneurysms occur in all age groups, the elderly comprised the largest group in our series. All of the 9 patients; 6 were men and 3 were women of mean age of 67 years (range, 57–83 years).

In our series, all patients were symptomatic, with symptoms having lasted for more than 7 days, and even up to 2 months. Classic manifestations include abdominal pain, fever, and a pulsatile abdominal mass. The presence of leukocytosis-elevated sedimentation rate and positive blood cultures strengthen the surgeon's suspicion of the diagnosis of infected aneurysm. Symptoms of sepsis may be discrete and may easily go unrecognized, especially in the early stages. Broad-spectrum antibiotics should be started preoperatively after taking blood cultures. Positive blood cultures are helpful to signal the need for the specific antibiotic therapy. CT scan is also in establishing the diagnosis of infected aortic aneurysm [12].

Although a period of antimicrobial therapy before EVAR is advised, immediate EVAR is indicated, irrespective of bacteriologic status, when there are signs of rupture. Emergency surgery was performed in 44.44% (n =4) of patients due to rupture. Three patients had focal aortic pseudo aneurysms with contained ruptures (75%) and 1 free ruptures (25%); CT scan confirmed all these. Three of the 4 (75%) ruptured infected abdominal aortic aneurysms were infected by *Salmonella* species (Table 1).

The surgical management of infected abdominal aortic aneurysms includes extensively resect the infected aorta, aggressively debride the periaortic tissues, and reconstruct the aortic flow using extra-anatomic or anatomic bypass prosthetic grafts [3,4,13]. Adequate drainage, administration of organism-specific parenteral antibiotics, extensive debridement and excision of infected aortic tissue are the strategies

used to resolve infection [2-5,14]. The virulence of the organism and severity of the arterial infection are more important determinants than any single operative procedure or method of arterial reconstruction [15]. The associated mortality was still high, ranging from 25% to 40% [2-5,13-15]. Death is usually related to persistent sepsis with multi-organ failure. The magnitude and long duration of the operation, especially in shocked and unstable patients, are major contributing factors to the perioperative mortality [3,14,15]. Late graft infections occurred in 7% to 10% of the cases [3,4,14], and extra-anatomic bypass had worse outcome than in situ reconstructions [4,13].

Endovascular treatment with stent-grafts has been introduced, as an alternative, less invasive, especially in the septic patient with considerable co-morbidity, will reduce the risk of cardiopulmonary, neurological and renal complications [16,17]. This could be a temporizing treatment prior to definitive open surgical repair, or a therapeutic alternative in critically ill patients who may not survive open surgery [18-20]. The potential benefits of endovascular repair include small incisions, minimal aortic cross-clamping time with reduction in end-organ ischemia, avoidance of general anesthesia, full heparinisation, single lung ventilation and cardiopulmonary bypass. Endovascular repair should reduce the length of stay in intensive care units, high dependency units and in hospital, with an earlier return to activities of daily living and consequent improvement in the quality of life [18-22]. An additional drainage procedure is usually required either via CT guided drainage or by open surgical approach [23]. On our previous experience on open surgical management of infected AAA, we had a disease-specific mortality was 31.25% (5/16). 30-day mortality rate of the ruptured cases is high 25% (4/16) [3]. We started EVAR for treatment of infected AAA since 2009 and hope that this alternative and less invasive procedure will decrease the patient's morbidity and mortality rates. We would go over on EVAR for treatment of infected AAA whenever the stents are available.

Immediate results are fair impressive; one patient (patient no. 6) developed left graft limb occlusion, which underwent successful thromboembolectomy; one (patient no. 3) underwent a minilaparotomy for open debridement due to persistent fever. There was no in-hospital death both in elective and emergency ruptured cases (Table 2).

Antibiotic administration according to postoperative sensitivity testing is crucial: the duration of antibiotic therapy is not well established, but most authors recommend a minimum of 6 weeks intravenously and orally for another 6 weeks [5,21]. Longer durations and even life-long antibiotic therapy have been recommended [3,20]. Some authors believe that patients with a prosthetic reconstruction should continue on low-dose antibiotics for life. However, the advantage of a more prolonged therapy has not been confirmed.

The midterm results are not satisfied due to high rate of infected stent grafts 33.33% (3/9). Three patients (patient no. 1, 5 and 7) had Infected Stent Grafts (ISG) at 10, 26 and 36 months after EVAR, which are disease specific complications, subsequently received CT-guided percutaneous tube drainage and needed later stent graft explantation due to unresponsive conservative management. Patient no. 1 underwent axillo-bifemoral bypass grafting and stent graft explantation. Patient no. 5 underwent stent graft explantation and In-situ Dacron graft interposition. Patient no. 7 refused stent graft explantation and died 1 month later at another hospital from aorto-enteric fistula with gastrointestinal bleeding and *E. coli* septicemia (Table 2).

Placing a foreign body in an infected field seems to be against the surgical infection principles. There is always concern about persistent infection after placing a stent graft in an infected field. Persistent infection after EVAR treatment of infected aortic aneurysms is usually associated with a poor prognosis. The endoprosthesis become infected so compounding the problem over a greater length of aorta, and they may cause rupture of a fragile vessel because of the necessary oversizing used to hold the device in place. Additionally, if the fever persists after the EVAR, This would be an indication to keep the patient on long-term broad-spectrum antibiotics until a definite surgical treatment is considered. Several reports have described a high incidence of recurrent infection and late mortality after endovascular repair [20,22].

Conservative management of infected stent grafts consists of antimicrobial therapy and percutaneous drainage (CT guided); is accepted in high-risk patients with multiple comorbidities and patients with minor, low-grade infections [19,21-25]. Mortality in these patients has been up to 40% [26]. In the series of Lyons et al. [27] reported that their patients who did not have stent grafts explantation died of aortic disease progression, contrasted with a mortality rate of 30% when the graft was explanted. In suitable patients: when an infected graft is not manageable by a conservative approach, surgical treatment should be considered [28].

The virulence of the organism and severity of the arterial infection are more important determinants than any single operative procedure or method of arterial reconstruction [29-32]. When there is gross contamination from infected stent grafts, excision and extra-anatomic bypass is the treatment of choice. The argument in favor of extra-anatomic bypass is the theoretic advantage of reducing the risk of graft infection, because revascularization is generally performed in a location remote from the site of infection.

When contamination is less severe, the aorta may be replaced *in situ*. The choice of the ideal conduit is still controversial. Rifampin soaked grafts may prevent graft infection by reducing early graft seeding [28,31-33]. Antibiotic-coated Dacron grafts presented an attractive adjunct. Prolonged anti-staphylococcal activity of rifampin-bonded, gelatin impregnated Dacron grafts has been demonstrated after implantation in the arterial circulation, in experimental and human studies. Infection rates, as well as mortality and morbidity rates, are much lower for rifampin-treated grafts than for plain in situ graft replacement [34]. Encouraging results have also been reported with the use of cryopreserved human allograft and silver coated polyester grafts [35]. Other safe alternatives include autogenous superficial femoral vein grafts and cryopreserved arterial allografts [36-39].

The duration of antimicrobial treatment in patients after removal of an infected aortic stent graft is controversial. No current guidelines exist on this issue and some authors suggest prolonging antibiotic administration until the C-reactive protein level has returned to baseline [40].

The immediate results of EVAR for Infected AAA are fair with no 30 days mortality and few complications. The midterm results are not satisfied due to high rate of infected stent grafts 33.33% (3/9). Endovascular treatment of Infected AAA is feasible and should be a durable treatment option; late infection-related complications do occur and are often lethal. EVAR could be considered a palliative treatment option, or a bridge to later elective radical open surgery, once the patient has recovered from the initial emergency.

## Conclusions

Endovascular treatment of primary Infected AAA is feasible and for most patients a durable treatment option. EVAR is not a definitive treatment of Infected AAA; it could be a temporizing treatment prior to definitive open surgical repair, or a therapeutic alternative in critically ill patients who may not survive open surgery. Late infections-related complications do occur; often lethal, need long-term antibiotic treatment and follow-up. In those cases, EVAR could be considered a palliative option or a bridge to later elective open repair.

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