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Endovascular treatment of primary mycotic aortic aneurysms: a 7-year single-center experience

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Abstract

Objective: This study was performed to assess the efficacy and outcome of endovascular aneurysm repair (EVAR) for treatment of primary mycotic aortic aneurysms (PMAAs).

Methods: Fourteen consecutive patients who presented with PMAA from April 2010 to July 2017 were retrospectively reviewed. Preoperative, intraoperative, and postoperative clinical data were recorded, and late infection-related complications and long-term survival were assessed.

Results: The aneurysms were located in the abdominal aorta in 10 patients and in the left common iliac artery in 4 patients. Positive microbial cultures were found in 12 patients, including *Salmonella* species in 11 and *Streptococcus* in 1. The remaining two patients had negative culture results. Ten patients received preoperative antibiotics before elective EVAR for 7 ± 9 days after admission. Four patients who underwent emergent EVAR due to ruptured aneurysms were given their first dose of antibiotics before EVAR. Three patients underwent surgical drainage, and six underwent percutaneous drainage within 30 days after EVAR. No death occurred within 30 days of the initial procedure. The mean follow-up was 34.8 (range, 3–84 months). One patient underwent re-intervention to resolve obstruction of the iliac/femoral artery 5 months postoperatively. Relapse of infection occurred in six patients (42.8%) during follow-up; infection-related death occurred in three of these patients. The other patients recovered with either conversion to open radical surgery or medical therapy. The actuarial 7-year survival after EVAR was 75.7%.

Conclusions: EVAR and aggressive antibiotic therapy might be suitable for PMAAs. Favorable results may be typical for infection caused by *Salmonella*.

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Introduction

A primary mycotic aortic aneurysm (PMAA) is a rare but fatal infectious disease with an incidence of less than 1% among all aortic aneurysms.[1,2] The disease carries a very poor prognosis because PMAAs cannot usually be diagnosed in the early stages, and treatment is administered with considerable delay once the aneurysm has been complicated by rupture or fulminant sepsis. Moreover, PMAAs tend to occur in patients with severe comorbidities, particularly those with immunodeficiency. Conventional open surgery with resection of the infectious aneurysm, extensive local debridement, and revascularization by in situ reconstruction or extra-anatomic bypass was historically regarded as the gold standard, but the treatment of PMAAs has changed during the last decade with a shift toward endovascular repair because of the high mortality and morbidity associated with surgical treatment. Endovascular aneurysm repair (EVAR) is becoming a reasonable initial alternative to open surgery for hemodynamically unstable patients with a ruptured PMAA or those with high surgical risk.[3] However, persistent infection is the main problem after EVAR.

We examined the outcomes of EVAR for PMAA in a single center during a 7-year period. This study was performed to obtain clinical findings that might help physicians to choose the most reliable strategy for the treatment of PMAA.

Material and Methods

This study was performed with approval of the Tianjin Medical University General Hospital Institutional Review Board. Verbal informed consent for the procedure was obtained from all participants.

This was a single-center, retrospective study of patients presenting with PMAAs at Tianjin Medical University General Hospital from April 2010 to July 2017. The diagnosis of PMAA was based on a combination of the following three criteria: (1) clinical symptoms (pain, fever, abdominal pain or back pain, or lumbosacral radiculopathy), (2) laboratory test findings (leukocytosis, elevation of inflammatory markers such as C-reactive protein and procalcitonin, or positive cultures), and (3) a characteristic appearance on radiologic imaging (saccular aneurysm, eccentric aneurysm, lobulated vascular mass, indistinct and irregular aortic wall, perianeurysmal soft tissue mass, and perianeurysmal gas) (Figure 1(a) and (b)). An infection-related complication was defined as recurrent sepsis, graft infection, aortoenteric fistula, or recurrence of a new PMAA in the same or a different location.

Patients with PMAAs were given intravenous antibiotic therapy for 1 week preoperatively and 6 weeks postoperatively, initially with broad-spectrum antibiotics and later guided by culture results. All patients were required to take oral antibiotics for at least 6 months upon discharge. Emergent EVAR was performed for patients with uncontrolled sepsis, an

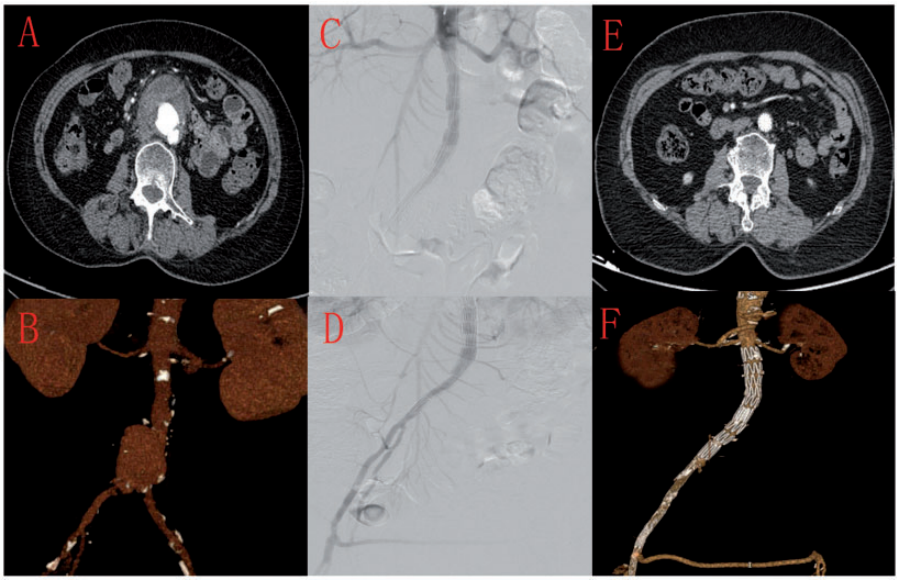


Figure 1. Imaging findings. (a, b) Preoperative computed tomography angiography showing a saccular aortic pseudoaneurysm at the abdominal aorta. (c, d) Aortogram demonstrating satisfactory endoluminal occlusion of the pseudoaneurysm after aorto-uni-iliac endovascular aneurysm repair with femorofemoral bypass. (e, f) Sixty-four-month postoperative computed tomography angiography showing complete eradication of the infected saccular aortic pseudoaneurysm in the abdominal aorta and patency of the bilateral femoral arteries.

unstable hemodynamic status, or evidence of impending aneurysmal rupture. Elective EVAR was performed for patients who were afebrile or had a good response to antibiotic therapy (i.e., decreasing white blood cell count and C-reactive protein level). An additional drainage procedure was usually needed by either computed tomography-guided percutaneous drainage (PTD) or an open surgical approach if periaortic abscess formation was found after EVAR.

Statistical analysis

Continuous variables are summarized using mean and standard deviation or median. Categorical variables are summarized using frequency and proportion. Survival estimates were generated using the Kaplan–Meier method. The data analysis was performed using SPSS, version 19.0 (IBM Corp., Armonk, NY, USA).

Results

During the 7-year study period, a total of 516 patients with aortic aneurysms (466 with abdominal aortic aneurysms and 50 with common iliac aneurysms) underwent EVAR or a surgical operation. Fourteen patients were included in this study [10 (71.4%) with mycotic abdominal aortic aneurysms and 4 (28.6%) with left common iliac mycotic aneurysms]. The patients' characteristics are listed in Table 1. All patients were symptomatic, with fever (12/14, 85.7%), abdominal and/or back pain (14/14, 100%), symptoms of lumbosacral radiculopathy (2/14, 14.3%), or shock (1/14, 7.1%). One patient was immunocompromised because of oral

Table 1. Patient characteristics.

Variables	Mean (range), n (%) or mean ± standard deviation (n = 14)
Age, years	63 (55–71)
Male sex	10 (71.4)
Fever	12 (85.7)
White blood cells, $\times 10^9$/L	14.3 ± 3.7
C-reactive protein, mg/L	7.6 ± 2.3
Aneurysm characteristics	
Aneurysm size, cm	4.8 ± 1.2
Contained rupture	4 (28.6)
Comorbid conditions	
Hypertension	9 (64.3)
Coronary heart disease	2 (14.3)
Renal insufficiency	3 (21.4)
Diabetes mellitus	7 (50.0)
Peripheral arterial disease	4 (28.6)
Dyslipidemia	4 (28.6)

steroid therapy for connective tissue disease. One patient had brucellosis.

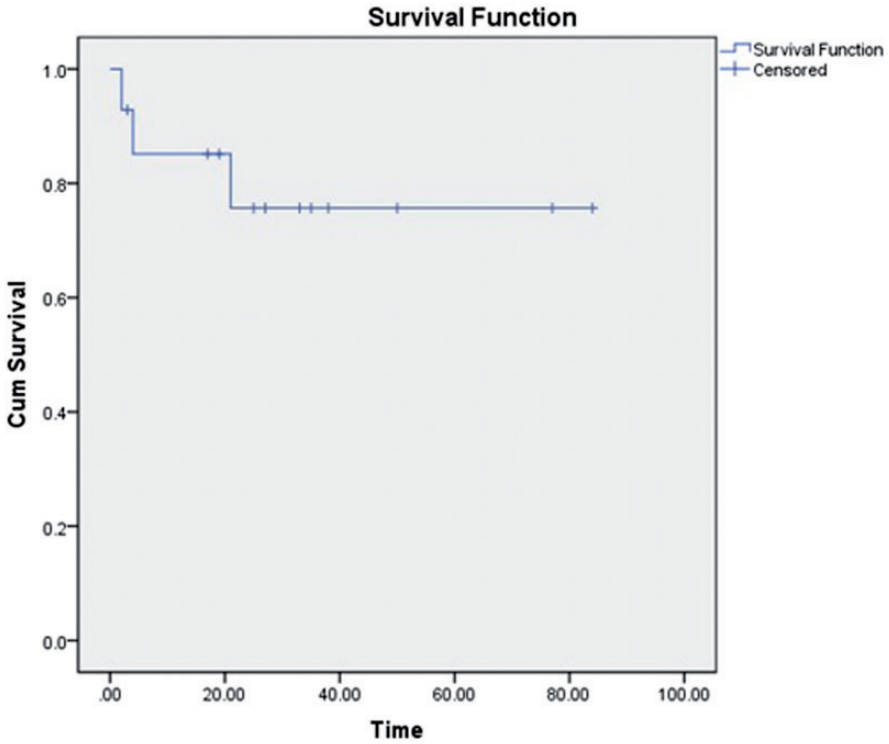
Among the preoperative blood cultures, 1 culture (7.1%) grew *Staphylococcus aureus*, 11 (78.6%) grew *Salmonella*, and 2 (14.3%) had negative culture results. Empiric broad-spectrum antibiotics were given to all patients and adjusted based on the culture result. Ten patients received preoperative antibiotic therapy before elective EVAR for 7 ± 9 days after admission until the body temperature, white blood cell count, and C-reactive protein levels were almost normalized. Four patients who underwent emergency EVAR because of ruptured aneurysms (one with free rupture and hemodynamic instability, three with a contained rupture but stable status) were given their first dose of antibiotics before EVAR. The treatments were EVAR with a chimney technique (n = 2), infrarenal EVAR (n = 11), and aorto-uni-iliac EVAR with femorofemoral bypass because of severe stenosis of the left iliac artery (n = 1) (Figure 1(c–f)). The device deployment success rate was 100%. A few type I endoleaks occurred in one patient, and type II endoleaks occurred in three patients.

Most patients (9 of 14, 64.3%) underwent drainage to treat an abscess surrounding the abdominal aorta or left common iliac artery as an additional procedure within 30 days after EVAR. Of these patients, three underwent surgical drainage and six underwent PTD. No death occurred within 30 days of the initial procedures.

The mean follow-up duration among the 14 patients was 34.8 months. Three patients died during follow-up. One patient died of hematemesis 2 months after EVAR. One patient died of recurrent sepsis at 21 months. A radical operation with axillo-bifemoral bypass using polytetrafluoroethylene prosthetic grafts was performed in two patients to treat recurrence of infection-related complications at 3- and 5-months of follow-up, respectively. One of the two patients died of gastrointestinal bleeding at 4 months, and the other patient survived with a 84-month follow-up. Two patients developed relapse of infection at 9 and 16-months of follow-up respectively, and recovered after 4 weeks of intravenous antibiotic therapy. The cumulative 7-year survival rate after EVAR was 75.7%, as seen in Figure 2.

Discussion

PMAA is a rare and complex disease with challenging treatment and a poor prognosis. Open surgery has been considered the conventional strategy for treating PMAA, but some studies have shown a much worse outcome after open surgery, with an in-hospital mortality rate of up to 30% to 40%[4,5] and much higher short- and long-term morbidity rates.[6,7] Furthermore, open surgery is unsuitable for high-risk patients with severe multiple comorbidities, a hostile anatomy, or rupture. Although



Time (months)	0	20	40	60	80
Number at risk	14	9	3	2	1

Figure 2. Kaplan–Meier 7-year survival curve of 14 patients treated for primary mycotic aortic aneurysms by means of endovascular aneurysm repair.

open repair can allow for extensive debridement of the infected aorta and surrounding tissues, it is difficult to ensure that no microinfected nidus is left and to prevent reinfection of the new prosthetic grafts.

The rapidly developing EVAR technique is becoming the preferred minimally invasive alternative to open surgery with favorable short-term outcomes in the treatment of PMAA. Some researchers have implied acceptable short-term and mid-term results of EVAR in the treatment of treat PMAA.[8,9] Once the arterial wall has been damaged by the infection, it becomes fragile. The damaged wall cannot sustain significant systemic arterial pressure, which might quickly lead to rupture. This may be the key reason why infected aortic aneurysms are usually associated with a high mortality rate. The favorable outcomes of EVAR in the treatment of PMAA might be associated with the prevention of infected aneurysm rupture.

However, several researchers have considered that although infected aneurysms were excluded by EVAR, the inside of the infected aneurysmal sac may lead to sepsis.[10] Once the infected aortic aneurysm has ruptured, the para-aortic soft tissues involved by the pathogen will become

a continuing source of infection. Kan et al.[9] considered that antibiotics may slowly permeate through the graft into the surrounding soft tissue to eradicate the infection because the graft is continuously exposed to the blood flow. Thus, long-term antibiotic therapy and aneurysm sac drainage, such as PTD or open drainage, have been suggested as adjuvant therapies for effective prevention of late relapse.

In this series, all patients except one accepted prolonged broad-spectrum antibiotic therapy. Unfortunately, the patient who discontinued the antibiotic therapy died of hematemesis 2 months after discharge. The reason for death may have been formation of an aortoduodenal fistula caused by the peri-aortic infection. Nine patients (64.3%) underwent drainage after EVAR, including three open surgical drainage procedures in the early stage of the study and six PTD procedures later. The drainage procedure helped to eradicate the infected foci surrounding the aneurysm. In our experience, PTD after EVAR is an effective strategy to control infection and prevent infection relapse.

Salmonella is the main blood culture-confirmed pathogen associated with infected aneurysms, and *Salmonella* infections are more common in East Asia.[11] Although *Salmonella*-infected aneurysms usually exhibit rapid disease progression with a risk of early rupture, patients with *Salmonella*-infected aneurysms showed a good response to antibiotic therapy and had acceptable long-term outcomes in some reports.[12,13] In contrast, the present study suggests that patients with non-*Salmonella*-positive blood cultures develop serious late complications.[14] Most of our patients (11/14, 78.6%) were infected with *Salmonella*, which might be one of the factors associated with our favorable outcomes.

The limitations of our study include its retrospective and observational design. Given the relative rarity of this disease, the cases obtained from a single center cannot be classified. Thus, the clinical data may be influenced by various confounders. Multicenter, prospective, large-scale studies are needed to elucidate the real outcomes of EVAR in the treatment of PMAA.

Conclusion

In our institution, EVAR combined with proper antibiotic therapy and adjuvant abscess drainage is recommended to treat PMAAs. The high 7-year survival rate (75.7%) in our study indicates the feasibility of EVAR to treat PMAA.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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