Extra-Anatomic Reconstruction for Infected Aorta

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Background: Mycotic aneurysms are rare in this age of antibiotic. But, they still represent as the life-threatening disease because of their high incidence of rupture and high rate of re-infection. Treatment of mycotic aortic aneurysm still remains confusing, especially in patients with severe aortic infection. Methods: From Oct. 1999 to Sep. 2002, there were 4 patients suffered from infected aorta with mycotic aneurysm formation. One was in descending thoracic aorta, 3 were in abdominal aorta. All 4 patients received the technique of extra-anatomic reconstruction due to severe periaortic invasion and preoperation impending rupture. We analyzed the data including age, gender, pre-operative characteristics, lesion location, operative procedure, complications, bacteriology, and antibiotic use. Results: The underlying infections of the aorta were treated successfully in all 4 patients. No recurrence of infected aorta and no infection of extra-anatomic prosthetic grafts were noted. Just 1 patient had neurologic sequela due to spinal artery ligation. All patients were caused by Salmonella infection. Appropriate antibiotics were given intravenously for 6 weeks. All patients discharged under stable condition. Conclusions: Although surgical treatments for mycotic aneurysms include extra-anatomic and in-situ reconstructions, recurrence and prosthetic infections still make surgeon in a dilemma. Our preliminary experience demonstrates that short-term outcomes of extra-anatomic reconstruction for mycotic aneurysm is satisfactory and demonstrates an improved disease-related survival. However, successful initial control of infection, a prerequisite for survival, is done with extra-anatomic reconstruction in our series.

Key words: extra-anatomic reconstruction, infected aorta, mycotic aneurysm

INTRODUCTION

Till today, aortic infections with mycotic aneurysm formation are still unusual that are difficult to control. Their essential features are the destruction of aorta by an infectious process. The secondary manifestations are aneurysm formation, embolization, and hemorrhage in the face of systemic septic illness. Although a variety of treatment modalities have been developed and overall results have improved in recent years, mortality rate of up to 50%, recurrent infection of up to 63% and amputation rate of up to 60% are reported¹². These considerable mortality and morbidity mainly result from re-infection and suture line problems, which lead to multiple reoperations and prolong antibiotic treatment³.

Conventional procedures usually encompass prosthetic in situ repair or extra-anatomic reconstruction for mycotic aneurysm. But, a review of the surgical literature regarding treatment of mycotic aneurysm can be confusing. Cardiac surgeons generally recommend in-situ graft replacement⁴. Peripheral vascular surgeons prefer excision, local debridement, and extra-anatomic reconstruction⁵⁶. However, in severe infection of mycotic aneurysm with intraaortic wall abscess and periaortic invasion, many studies still suggested that extraanatomic reconstruction had a lower rate of recurrence and prosthetic infection, even lower mortality and morbidity⁵⁷. In our department, successful treatment of mycotic aortic aneurysm by extra-anatomic reconstruction, improvement in antibiotic therapy, and accurate evaluation of septic diffusion by computerized tomographic (CT) scan give us a new interest to control infected aorta.
MATERIALS AND METHODS

Patient

From Oct. 1999 to Sep. 2002, 4 consecutive patients with mycotic aneurysms of thoracic or abdominal aorta undergoing excision and debridement of the aneurysm and adjacent tissue with extra-anatomic bypass were enrolled in this study. There were 2 male patients and 2 female patients aged between 56- and 68-year-old. The basic characteristics, lesion location, operative procedure, complications, bacteriology, antibiotic use, and early outcomes of the patients were analyzed.

Computerized tomographic (CT) scan was performed preoperatively in all patients to evaluate the characteristic anatomic features of lesion, including location, aneurysm shape and size, periaortic invasion, and even the presence of focal defect of aortic wall. Blood cultures were collected for identifying the type of organisms when mycotic aneurysms were suspected initially. It is important because blood culture represents the earliest reliable clue to the presence of aortic infection and gives us a guide for antibiotic treatment preoperatively.

Operative Technique

For infection of the descending thoracic aorta, a median sternotomy combined with a left thoracotomy was made. Cardiopulmonary bypass was stand-by. Mycotic aneurysm was excised. The proximal and distal ends of aorta were ligated with 3-O prolene suture. Periaortic abscess, necrotic debris, and inflamed tissue were debrided adequately. Autologous pericardium was used for coverage of proximal and distal stumps. Then, an extra-anatomic bypass from the ascending aorta to the abdominal aorta with Hemashield vascular graft was performed.

Three patients suffering from infrarenal aortic mycotic aneurysm were treated by aneurysm resection associated with axillofemoral bypass (1 axillobibifemoral and 2 axillounifemoral). Extraanatomic bypass was performed before aneurysm resection. After all incisions were closed, exploratory laparotomy was performed. Mycotic aneurysm was excised, the distal & proximal stump were sutured with 3-O prolene. The periaortic pus and necrotic debris were debrided. A pediculated omental flap covered previous infected area and all sutures. Three Sil-Med drainages were placed at retroperitoneal, subphrenic, and pelvic areas.

Postoperative Antibiotic Therapy

Preoperative blood culture and aortic wall bacteriologic examination were performed in all cases. All 4 patients had positive blood culture preoperatively. Immediate broad-spectrum antibiotics were instituted when infection of aorta was suspected. Specific antibiotics was given when causitive organisms were identified. After operations, patients received intravenous antibiotic treatment for 6 weeks. No oral antibiotic was continued. No recurrence of prothetic infection were noted at hospital or after discharge.

RESULTS

The clinical characteristics of patients were shown at Table 1. All patients had severe symptoms and signs of sepsis and aneurysm effects before surgery, including chill and fever, leukocytosis, elevated ESR and CRP, hemoptysis, abdominal palpable mass, and lower back pain. All patients received CT scan preoperatively. Hematoma around the aorta and leakage of contrast material were noted in 3 patients of abdominal aortic mycotic aneurysms which revealed impending rupture. The mycotic aneurysm of thoracic descending aorta was saccular form which revealed rupture with pseudoaneurysm formation. Two patients of abdominal aortic mycotic aneurysm had periaortic abscess, air in aortic wall, and vertebral disc invasion. All 4 patients received the emergency operations. The indications for operation were septic shock with poor medical control in 1 patient and impending rupture with unstable vital signs in other 3 patients.

All patients received extraanatomic reconstruction to reestablish the aortic continuity because of severe aortic infection with pus in aneurysm cavity, purulent periaortic tissue, and periaortic invasion. The location of mycotic aneurysms was shown at Table 1. All patients had severe symptoms and signs of sepsis and aneurysm effects before surgery, including chill and fever, leukocytosis, elevated ESR and CRP, hemoptysis, abdominal palpable mass, and lower back pain. All patients received CT scan preoperatively. Hematoma around the aorta and leakage of contrast material were noted in 3 patients of abdominal aortic mycotic aneurysms which revealed impending rupture. The mycotic aneurysm of thoracic descending aorta was saccular form which revealed rupture with pseudoaneurysm formation. Two patients of abdominal aortic mycotic aneurysm had periaortic abscess, air in aortic wall, and vertebral disc invasion. All 4 patients received the emergency operations. The indications for operation were septic shock with poor medical control in 1 patient and impending rupture with unstable vital signs in other 3 patients.

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acute occlusion of extraanatomic prosthetic graft with acute and mitral valve stenosis (MS), and atrial fibrillation had been followed an average of 16.25 months (range 4 to 37nism may result from 1 of the 4 mechanisms: (1) bacterial inoculation during direct trauma (i.e., accidental, (2) septic microemboli that (1) bacterial inoculation during direct trauma (i.e., accidental, self-induced, or iatrogenic), (2) septic microemboli that causes disruption of the arterial wall and invasive infection, (3) local extension of an infected focus, and (4) trapping of bacteria in atherosclerotic plaques in a episode of (3) local extension of an infected focus, and (4) trapping of bacteria in atherosclerotic plaques in a episode ofaortic infection associ-
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hed morbidity and mortality. The rarity of such diseases, the optimal treatment, the length of antimicrobial therapy, and even the appropriate use of the term are not well established and still remain controversial10,13. However, once the diagnosis has been established, early definitive intervention must be initiated. Successful treatment should include 2 elemental principles: (1) control of sepsis: antibiotic therapy and adequate surgical debridement, and (2) establishment of arterial continuity: some form of arterial reconstruction12. For many years, the standard surgical principle for the treatment of my-

DISCUSSION

Mycotic aneurysm have been reported in all age group, even in newborn, but, the typical patient is elderly and atherosclerotic8,9. In our series, the mean age of patients, 62.3 years, was comparable to that for all of the others who underwent aneurysm surgery in previous reports10.

The term mycotic aneurysm was first coined by Osler in his description of a fresh fungus vegetation at the orifice of the aortic arch in 188511. As he described it, the true mycotic aneurysm is limited to the unique clinical condition characterized by bacterial endocarditis with septic embolization from valvular vegetations. Although mycotic aneurysm is a misnomer since most of these aneurysms are caused by bacteria infection rather than by fungus organisms and aneurysms of infectious etiology were diversified, the term has acquired a broader significance and had become synonymous with the broad syndrome-
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Table 2 Localization, operation, and complication for infected aorta

<table>
<thead>
<tr>
<th>Patient</th>
<th>Location</th>
<th>Extra-anatomic reconstruction</th>
<th>Complication</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Infraenal abdominal aorta</td>
<td>Axillabifemoral bypass with 8 mm PTFE graft</td>
<td>Re-operation for distal stump bleeding</td>
</tr>
<tr>
<td>II</td>
<td>Descending thoracic aorta (ischmus area)</td>
<td>Ascending aorta to abdominal aorta extraanatomic bypass with 16 mm Hemashield graft</td>
<td>Re-operation for checking bleeding, L't pleural effusion</td>
</tr>
<tr>
<td>III</td>
<td>Infraenal abdominal aorta</td>
<td>Bil axilofemoral bypass with 8 mm PTFE graft</td>
<td>R't lower leg weakness, Bili lower leg numbness</td>
</tr>
<tr>
<td>IV</td>
<td>Infraenal abdominal aorta</td>
<td>Bil axilofemoral bypass with 8 mm PTFE graft</td>
<td>(-)</td>
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</tbody>
</table>

PTFE: Polytetrafluoroethylene.

Table 3 Bacteriology and antibiotic use

<table>
<thead>
<tr>
<th>Patient</th>
<th>Causative Agent</th>
<th>Antibiotic</th>
<th>Duration</th>
</tr>
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<tbody>
<tr>
<td>I</td>
<td>Salmonella</td>
<td>Ceftriaxone</td>
<td>6 wks</td>
</tr>
<tr>
<td>II</td>
<td>Salmonella</td>
<td>Ceftriaxone</td>
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Reconstruction for infected aorta

cotic aneurysm should consist of aortal or arterial ligation, excision of all infected tissue and extra-anatomic bypass grafting through a clean non-infected plane. In recent years, in-situ prosthetic reconstruction has received emphasis\textsuperscript{14-16}. It offers a definite solution by one single operation and the preliminary results are encouraging. But, their good experience were just in the instances where were simple, no rupture, minimal contamination, no pus, and less extent of the infection process. In high-grade infection with periaortic invasion and preoperative aneurysm rupture with shock, recurrence, graft infection, and stump slough were reported in their series\textsuperscript{14-16}. Ewart and associates demonstrated a 23% to 63% reoperation rate for graft infection after immediate in-situ reconstruction, and just a 7% recurrent infection rate when patients were initially treated with aorta debridement and extra-anatomic reconstruction\textsuperscript{7}. Brown and his co-work, in their review of 51 cases of mycotic aneurysm, also noted that the mortality of local graft reconstruction was 32%, where extra-anatomic reconstruction patients suffered a 13% mortality rate\textsuperscript{6}. Besides, cryopreserved homografts were introduced in recent years. It may reduce postoperative infection rates and improved survival in this group of high-risk patients\textsuperscript{15,17}. But, several disadvantages were recognized, such as difficulties with procurement and preservation, secondary dilatation and calcification caused by degeneration\textsuperscript{17}. Furthermore, most patients require emergency operation because mycotic aneurysm has typically ruptured by the time of diagnosis, and access to a tissue bank is generally not available.

"The concept of extra-anatomic reconstruction emerged simultaneously with other major developments in vascular surgery during the early 1950s. In 1952, Freeman and Leeds described the use of superficial femoral artery as a conduit for a crossover femorofemoral bypass graft\textsuperscript{18}. In 1958, McCaughan and Kahn sutured a polyester (Dacron) grafting through a clean non-infected plane. In recent years, it may reduce postoperative infection rates and improved survival in this group of high-risk patients\textsuperscript{15,17}. But, several disadvantages were recognized, such as difficulties with procurement and preservation, secondary dilatation and calcification caused by degeneration\textsuperscript{17}. Furthermore, most patients require emergency operation because mycotic aneurysm has typically ruptured by the time of diagnosis, and access to a tissue bank is generally not available."

As reported in various studies, the most common pathogens today are staphylococci, streptococci, and Salmonella sp\textsuperscript{27}. In our series, all mycotic aneurysms were infected by Salmonella sp. Salmonellae often have a propensity for infection of vascular sites such as the aorta and other large- and medium-sized vessels. The clinical pictures in mycotic aneurysms consisted almost invariably of recurrent fever and chills; other symptoms were related either to the primary source of infection (e.g., diarrhea) or to the site of the aneurysm itself (e.g., chest discomfort, abdominal distension, palpable abdominal pulsatile mass, dyspnea, hemoptysis)\textsuperscript{10,31}. It should be noted that the primary source of the bacteremia is often undetermined. CT scanning is the most diagnostic medium; aortography was performed for confirmation or surgical planning. The optimal duration of systemic antimicrobial therapy has not been clearly defined, and antibiotic therapy recommendations range from several weeks to a long time even lifelong\textsuperscript{18}. Most authors advocate 4 to 6 weeks of intravenous antibiotics. Nevertheless, for cases involving repair of mycotic aneurysms with prosthetic material, some experts have recom-
mended permanent antibiotic treatment, as late recurrent infections have been reported\textsuperscript{15}. In our series, all patients just received 6 weeks of intravenous antibiotic treatment. No oral antibiotics were continued after discharge. After long term follow-up, not any recurrence were noted. Untreated mycotic aneurysm due to Salmonella species is invariably fatal. Without surgical intervention, there had been no long-term survival. All mycotic aneurysm have high rate of spontaneous rupture, even use of antibiotic cannot decrease the rate of rupture. As the diagnosis is defined, surgical treatment should be interventioned as soon as possible\textsuperscript{12}.

In conclusion, in-situ reconstruction seems to be a promising and effective concept, particularly with cryopreserved homografts. It supplied a simple and rapid method for the treatment of mycotic aneurysm. But, we believe that an extra-anatomic reconstruction should be proposed as a first-choice procedure if diffuse retroperitoneal sepsis with pus formation, periaortic extension, and osteomyelitis of vertebral body are found on CT scan, or impending rupture with shock and unstable condition pre-operatively. The short term results of our studies also support the use of extraanatomic techniques to avoid graft infection and recurrence, and reduce the mortality and morbidity in high-grade infection. Although the patency rate is the major consideration for surgeon to select extraanatomic reconstruction, in our series and many reports, they seem to be acceptable. Some authors even suggested that patients in good condition after extraanatomic grafting can be considered for anatomic reconstruction when infection is well control\textsuperscript{12}.

REFERENCES

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