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New Bacteriological Patterns in Primary Infected Aorto-iliac Aneurysms: A Single-centre Experience

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Abstract *Objectives:* To assess causative pathogens and surgical outcomes in patients with primary infected aorto-iliac aneurysms at our institution.
Design: Retrospective study of patients treated at a university hospital between 1992 and 2009.
Results: We identified 26 patients (median age, 63 years) with primary infected aneurysms on the aorta (descending thoracic, $n = 2$; thoraco-abdominal, $n = 3$; suprarenal, $n = 2$; infrarenal, $n = 15$) or iliac arteries ($n = 4$). Among them, 22 were symptomatic, including 13 with ruptured aneurysms. The causative organisms, identified in 25/26 patients, were *Campylobacter fetus*, $n = 6$; *Streptococcus pneumoniae*, $n = 4$; *Listeria*, $n = 3$; *Salmonella*, $n = 2$; *Mycobacterium tuberculosis*, $n = 2$; *Staphylococcus aureus*, $n = 1$; and other, $n = 7$. Immune suppression was a feature in 10 (38.4%) patients. Revascularisation was performed *in situ* in 23 patients (10 allografts, eight grafts, three superficial femoral veins, and 2 stentgrafts) and by extra-anatomic bypass in three patients.
Hospital mortality was 23% (*in situ* group, 17.4%; extra-anatomic group, 66.7%; χ^2_{Yates}, $P = 0.24$). During follow-up in the 20 survivors (median, 48.5 months), there were two non-infection-related deaths (five and 24 months) and six (30%) vascular complications.
Conclusions: The bacteriological spectrum of primary infected aorto-iliac aneurysms was wider than previously reported. The availability of new diagnostic tests and increased prevalence of immunosuppression may explain this finding.

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Primary infected aorto-iliac aneurysms include infected pre-existing aneurysms and aneurysms caused by bacterial aortitis. Although they contribute only 1–3%[1,2] of all aorto-iliac aneurysms, they raise challenges for vascular surgeons, because they are associated with high morbidity and mortality rates. Previous studies found that *Salmonella*, *Staphylococcus* and *Streptococcus* were the main pathogens involved.[2–5] Data from our institution suggested changes in recent years in the organisms causing primary infections of aorto-iliac aneurysms.[6,7]

The objective of this study was to review our experience with patients managed for primary infected aorto-iliac aneurysms over a 17-year period, with the goal of evaluating the causative organisms and surgical outcomes.

Patients and Methods

We identified all patients managed at the vascular surgery department of our institution (Henri Mondor Teaching Hospital, Créteil, France) between 1992 and 2009 for primary infected aortic or iliac aneurysm distal to the left subclavian artery. Primary aorto-iliac aneurysm infection was diagnosed in patients with (1) clinical evidence of infection (fever, pain and leucocytosis), and (2) intra-operative findings of inflammation and pus and (3) positive blood or aneurysm wall cultures. We also included patients who had negative cultures if they had convincing operative findings, fever of unknown origin and at least 1 week of preoperative antibiotic treatment. Finally, patients managed with endovascular repair were included if they had suggestive clinical symptoms, positive blood cultures and computed tomography (CT) or magnetic resonance imaging (MRI) evidence of infection (rapid increase in aneurysm diameter, saccular aneurysm, festooned and irregular arterial contour, abscess, vertebral lysis or retroperitoneal collection without evidence of rupture). We did not include patients with aneurysms of the ascending aorta, aortic arch or aortic branches; prosthetic graft infections; or positive aneurysm wall cultures without evidence of active infection.

We collected the study data via retrospective review of the prospective database of our vascular surgery department, according to institutional review board protocols specific to our institution. Additional data were collected from the patient medical records. We recorded the following data: age, gender, site of the infected aneurysm, clinical presentation (pain, leucocytosis, fever and C-reactive protein (CRP) elevated to at least twice the baseline value), risk factors (atherosclerosis, diabetes and immunodeficiency), history of recent infection, results of blood and intra-operative cultures, results of imaging studies, operative findings and techniques, duration of antibiotic therapy, in-hospital and long-term mortality, and short- and long-term surgical complications including graft infection and persistent signs of infection.

Follow-up data were obtained from outpatient records. We recorded the findings from imaging studies (Duplex scan, CT, MRI) and laboratory tests (e.g., blood cell counts and CRP). Information about patients, who died during follow-up, was obtained from autopsy reports, official death certificates and interviews with the patients' physicians or relatives.

Results

From March 1992 to April 2009, 26 patients with primary infected aortic or iliac aneurysms were managed at our institution. Table 1 shows the main symptoms, micro-organisms, aneurysm features, treatments, and outcomes.

Clinical patterns

There were 19 men and seven women (sex ratio, 2.71:1) with a mean age of 63 years (range, 23–86 years). Table 2 lists the clinical features, laboratory findings and co-morbidities. Prior hospital admission was noted in three patients, among whom one had a *Staphylococcus aureus* leg abscess, one had *Aspergillus* nephropathy after heart transplantation and one had *Streptococcus* endocarditis 1 month before admission for the aneurysm infection. In these three patients, we found the same organisms in the primary infected aneurysms.

Preoperative imaging

Preoperative imaging was performed in all patients, using either CT ($n = 24$) or MRI ($n = 2$). Table 3 lists the main findings. The aneurysm was located at the iliac artery in four (15%) patients and at the infrarenal aorta in 15 (58%). One patient had a pararenal aneurysm treated via a retroperitoneal approach and another a suprarenal aneurysm treated via a thoraco-abdominal approach. In addition, three (11%) patients had thoraco-abdominal aneurysms and two (8%) had aneurysms limited to the descending aorta. Of note, one of the patients with thoraco-abdominal aneurysms also had a primary infected aneurysm of the common femoral artery.

Bacteriological findings

Table 1 lists the bacteriological findings. Positive cultures were obtained from the aneurysm wall or surrounding tissues in 22 (84.6%) patients and/or from blood in 16 (61.5%) patients, and 25 (96%) patients had at least one positive culture. In the patient with negative aneurysm wall and blood cultures, preoperative serological tests established a definitive diagnosis of Q fever.[8] In one patient, two organisms were found, *Streptococcus oralis* by the aneurysm wall culture and active tuberculosis by histopathogical examination of the operative specimen (epithelioid granulomas and caseous necrosis).

Surgical findings

Of the 26 aneurysms included in the study, five (19.2%) were ruptured at the time of surgery. Of the three patients with non-contained rupture and shock, one had an aneurysm of the visceral aorta ruptured into the pleural space and two had infrarenal aneurysms, ruptured into the abdominal cavity and retroperitoneal cavity, respectively. Of the two remaining ruptured aneurysms, one was an infrarenal aneurysm ruptured into the third duodenum, with severe haematemesis, and the other was a thoracic

Table 1 Main features in the 26 study patients.

Patient #	Age (sex)	Bacteria	BC	AWC	Location	Intervention	30-day deaths day (cause)	Outcome	Follow-up (months)
Extra-anatomic bypass									
1	62 (F)	*Salmonella*	+	−	IRA	Dacron (axillo-femoral bypass)	5 (sepsis)	−	−
2	37 (M)	*Propioni-bacterium* + *Coryne-bacterium*	−	+	IA	SFV* (femoro-femoral bypass)	−	−	48
3	37 (M)	*Streptococcus pneumoniae*	+	+	IA	GSV** (femoro-femoral bypass)	16 (valve detachment)	−	−
In situ bypass									
4	69 (M)	*Campylobacter fetus*	+	+	IRA	Dacron (aorto-biiliac bypass)	−	Graft infection (D21) (sepsis)	34
5	69 (M)	*Campylobacter fetus*	+	+	IRA	Silver (aorto-bifemoral bypass)	−	Graft infection (D15) (sepsis)	28
6	76 (M)	*Campylobacter fetus*	−	+	IRA	Dacron (aortic tube graft)	−	Death unrelated to infection	5
7	76 (M)	*Campylobacter fetus*	+	−	IRA	Zenith bifurcated stentgraft	15 (sepsis)	−	−
8	78 (M)	*Campylobacter fetus*	+	+	IRA	Allograft (aortic tube graft)	−	−	38
9	79 (M)	*Campylobacter fetus*	+	−	IA	Zenith aorto mono-iliac stentgraft, femoro—femoral bypass	−	−	100
10	59 (F)	*Streptococcus pneumoniae*	+	+	DTA	Allograft (aortic tube graft)	−	−	36
11	62 (M)	*Streptococcus pneumoniae*	−	+	TAA	Allograft (aortic tube graft, LRA**** bypass)	−	Severe bleeding (D 11), paraplegia, Haemorrhage (2 m, stentgraft)	10
12	76 (M)	*Streptococcus pneumoniae*	+	+	IRA	Allograft (aortic tube graft)	−	−	16
13	64 (M)	*Listeria monocytogenes*	+	+	IRA	Allograft (aortic tube graft)	−	−	16
14	64 (M)	*Listeria monocytogenes*	+	+	IRA	Allograft (aortic tube graft)	−	Collection (6 m)	81
15	65 (M)	*Listeria monocytogenes*	+	+	IRA	Silver soaked with rifampin (aorto-biiliac bypass)	−	Graft infection (19 m) (sepsis)	19
16	23 (F)	*Mycobacterium tuberculosis*	−	+	TAA	Dacron (aortic tube graft)	−	−	170
17	37 (F)	*Mycobacterium tuberculosis*	−	+	IRA	Silver (aortic tube graft)	−	−	16
18	77 (M)	*Streptococcus oralis*, *Mycobacterium tuberculosis*	−	+	IRA	SFV* (aorto-biilac bypass)	−	Collection (3 m)	112
19	40 (M)	*Aspergillus*	+	+	IA	Allograft (aorto- bifemoral)	5 (colonic ischaemia)	−	−

20	61 (M)	*Haemophilus influenzae*	+	+	IRA	SFV* (aorto-biiliac bypass)	–	Collection (3 m)	3
21	64 (M)	*Coxiella burnetii*	–	–	IRA	Allograft (aorto-biiliac bypass)	–	Colonic ischaemia (D7)	38
22	67 (F)	*Proteus mirabilis*	–	+	SRA	Silver (aortic tube, RRA*** bypass)	–	LRA angioplasty (4 m)	31
23	69 (F)	*Escherichia coli*	+	+	JRA	Allograft (aortic tube graft)	30 (haemorrhage)	–	–
24	70 (M)	*Staphylococcus aureus*	+	+	TAA	Dacron (aortic patch, LRA-CT**** bypass)	7 (colonic ischaemia)	–	–
25	71 (M)	*Salmonella*	–	+	DTA	Silver (aortic tube graft)	–	–	96
26	86 (F)	*Enterococcus faecalis* + *Peptostreptococcus*	–	+	IRA	Allograft (aortic tube graft)	–	Death unrelated to infection	26

BC, blood culture; AWC, aortic wall culture; IRA, infrarenal aorta; IA, iliac artery; SRA, suprarenal aorta; TAA, thoraco-abdominal aorta; DTA, descending thoracic aorta; JRA, juxtarenal aorta.
*SFV, superficial femoral vein; **GSV, great saphenous vein; ***RRA, right renal artery; ****LRA-CT, left renal artery and celiac trunk.

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Figure 1 Right psoas abscess.

ortic aneurysm ruptured into the lung. Chronic contained rupture with diffusion to peri-aortic tissues was found in eight (31%) patients. The remaining 13 (50%) patients had unruptured aorto-iliac aneurysms at the time of surgery.

Operative treatment

All patients underwent primary vascular reconstruction. The type of procedure was at the discretion of the operating surgeon, who made decisions based on the features in each individual patient and on the availability of autologous or allogeneic graft material.

The surgical procedures were classified as emergent ($n = 10$), quasi-emergent (within 48 h of surgical vascular consultation, $n = 6$), or elective ($n = 10$). *In situ* aortic reconstruction was performed in 23 (88.4%) patients and extra-anatomic bypass surgery in three (11.6%) patients. In the *in situ* group, the bypass materials were as follows: silver-coated polyester graft (InterGard Silver; InterVascular, La Ciotat, France) in five (22%) patients, including one managed with a rifampin-soaked graft; various standard rifampin-soaked Dacron prostheses in four (17%) patients, aortic allogeneic material in 10 (43%) patients,

Figure 2 Penetrating ulcer with gas in the aortic wall (arrows).

Table 2 Main features in the study patients.

	N	%
Clinical presentation		
Fever	21	80%
Pain	22	84.6%
Haemorrhagic shock	3	11.5%
Renal failure	3	11.5%
Respiratory failure	1	3.8%
Immunodepression	10	38.4%
Malignant disease	7	26.9%
Immunosuppressive therapy	2	7.6%
Long-term steroid medication	1	3.8%
Diabetes mellitus	6	23%
Cardiovascular risk factor	23	88.4%
Laboratory features		
Leukocytosis	16	61.5%
High CRP level	13	50%

CRP, C-reactive protein in serum.

autologous superficial femoral vein in two (9%) patients and aortic stentgraft in two (9%) patients. Of the three patients managed by extra-anatomic bypass surgery, one patient with an infrarenal aortic aneurysm was treated by thoracic aorta ligation and axillofemoral bypass and two patients with right common iliac artery aneurysms were treated by ligation and femoro-femoral venous bypass (great saphenous vein and superficial femoral vein, respectively). Extensive debridement of the aneurysm and adjacent necrotic material was performed in 23 (88.4%) patients. In addition, the following vascular procedures were performed in seven patients: aorto-renal artery bypass ($n = 3$), re-implantation of the inferior mesenteric artery ($n = 3$), and celiac-to-left renal artery bypass ($n = 1$). The graft was protected by omental flap interposition in seven (31%) patients, Vicryl mesh in one (4%) patient, and simple retroperitoneal closure in nine (38%) patients. In six (27%) patients, graft protection was not necessary (descending thoracic aorta aneurysms, stentgraft, or extra-anatomic bypass). Finally, three patients had combined abdominal procedures (duodenal suture with jejunal bypass, right nephrectomy and Hartmann procedure, respectively).

Antibiotic therapy

In 14 (54%) patients, antibiotics were taken before surgery, for a mean of 9.9 days (range, 3—21 days). Antibiotic therapy was initiated just before surgery in the remaining 12 patients. Moderate- or broad-spectrum empirical antibiotics (usually a penicillin with an inhibitor and an aminoglycoside) were given intravenously and the treatment was subsequently adjusted based on microbiological study findings. Mean duration of intravenous antibiotic therapy was 15 days (range 0—30 days). Oral antibiotics were then given for a mean duration of 11 weeks (range, 1—52 weeks).

Table 3 Preoperative imaging findings.

Preoperative imaging	*n*	Percentage
Ruptured	11	42.3%
Contained	4	15.4%
Non-ruptured	15	57.7%
Saccular aneurysms	6	23%
Abscess (Fig. 1)	3	11.5%
Gas in the aortic wall (Fig. 2)	2	7.6%

Early outcomes

Six (23%) patients died in the perioperative period, four (4/23, 17.4%) following *in situ* bypass and two (2/3, 66.7%) following extra-anatomic bypass. No patients died in the operating room; all six deaths occurred between days 5 and 30 (mean, 13 days). Two patients managed with *in situ* bypass died from multi-organ failure associated with colon ischaemia 5 and 7 days after surgery, respectively. Fatal septic shock occurred in two other patients (one managed with an extra-anatomic bypass and 1 with a stentgraft), on postoperative days 5 and 14, respectively. One patient, with iliac primary aneurysm infection related to endocarditis treated with two bioprostheses, died 16 days after extra-anatomic bypass surgery, from acute pulmonary oedema due to valve detachment. The remaining patient underwent *in situ* bypass combined with right nephrectomy for septic rupture of the renal artery origin and right pyonephrosis. Six days after surgery, she developed a left kidney infection and thrombosis of the left renal vein and inferior vena cava with pulmonary embolism. Despite left nephrectomy, inferior vena cava thrombectomy, haemodialysis, and surgery 3 days later to treat retroperitoneal bleeding, she died on day 30 from severe bleeding after evacuation of a large retroperitoneal abscess.

Major postoperative complications occurred in 14 (54%) patients. They consisted of transient renal failure ($n = 6$, 23%), permanent renal failure ($n = 3$, 12%), respiratory failure requiring prolonged ventilation ($n = 3$, 12%), pneumonia ($n = 2$, 8%) and arrhythmia ($n = 1$, 4%). Surgical complications occurred in nine (34.6%) patients and consisted of severe bleeding ($n = 3$), colon ischaemia ($n = 3$) and paraplegia ($n = 1$). Two patients with ruptured infrarenal aneurysms infected with *Campylobacter fetus* experienced graft infection requiring emergency surgery; one was managed with a Dacron aorto-biiliac bypass graft and the other with a silver-coated polyester aorto-bifemoral bypass graft. They remained febrile after surgery despite appropriate antibiotic therapy. CT showed fluid around the graft in both patients and gas around the graft in one patient. Both patients were managed with total graft removal followed by reconstruction with aorto-femoral and femoro-femoral bypasses using autologous superficial femoral vein, 2 and 3 weeks after the first surgical procedure, respectively, without further complications.

Late outcomes

Mean clinical follow-up was 46 months (range, 3—170 months) in the 20 survivors. One patient was lost to follow-up 3 months after surgery. Two patients died during follow-up, 5 and 26 months after surgery, respectively, from unrelated causes: one of them had no evidence of recurrent

infection by follow-up CT 2 months before death and the other had no clinical or laboratory evidence of infection at follow-up 6 months before death.

Late vascular complications, including two related to the graft, occurred in six (30%) of the 20 survivors. One of the patients with late graft-related complications had been treated for an infrarenal aortic aneurysm with recovery of *Listeria* from aneurysm wall cultures. The procedure had consisted of total aneurysm excision, silver-coated polyester aorto-biiliac bypass grafting, and a Hartmann procedure required by intra-operative colon ischaemia. The only post-operative complication was arrhythmia. However, 19 months later, he was admitted for persistent fever with elevated inflammation markers but negative blood cultures. CT showed a peri-prosthetic collection with increased uptake by positron-emission tomography (PET)/CT. Surgery was performed for total graft excision and aorto-biiliac bypass grafting using allogeneic material. There were no post-operative complications. The other patient with a late graft-related complication had been managed with *in situ* bypass grafting of allogeneic material for a thoraco-abdominal aneurysm infected with *Streptococcus pneumoniae*. On day 11, severe bleeding due to a tear in the suture connecting the two allografts required further surgery, which was complicated by paraplegia. Two months later, he was referred to our department on an emergency basis for haemothorax and pneumopathy. CT showed contrast material leakage between the two allografts. He was treated with stentgraft insertion via the left subclavian artery and had no evidence of recurrence 8 months after this third procedure. Of the remaining four patients with late vascular complications, three had persistent deep collections about the graft (two autologous superficial femoral vein grafts and one allograft) with no evidence of infection at follow-up (3—112 months). These patients were not considered as having graft-related complications. The remaining patient also had a vascular complication unrelated to the graft that consisted in post-ostial stenosis of the left renal artery stenosis treated with angioplasty and stenting.

Finally, one patient treated with *in situ* allogeneic bypass grafting for an infrarenal aortic aneurysm infected with *C. fetus* had elevated laboratory markers for inflammation for the first 6 postoperative months, with no evidence of persistent infection (no leucocytosis, negative blood cultures and no collections about the graft).

Discussion

We found a higher rate of atypical micro-organisms compared with previous case series,[2—5] in which *Staphylococcus*, *Salmonella*, and *Streptococcus* predominated. Among the 26 patients, the majority had infections related to other micro-organisms including *C. fetus*, *Listeria monocytogenes*, *Mycobacterium tuberculosis*, *Coxiella burnetii* and *Aspergillus* species. Twelve patients were infected with more common bacteria, essentially *Streptococcus* species and minor *Salmonella*. *S. aureus* was found in a single patient.

This difference may be explained in part by the high proportion of patients with organisms recovered from blood and/or tissue cultures in our study (96%). In other large case series, 14—40% of patients had negative bacteriological studies. Furthermore, the identification of the most common bacteria in our series, that is, *Campylobacter* and *Listeria*, is known to be difficult, as it requires prolonged culturing on enriched, micro-aerophilic media.[9—12]

However, the use of sensitive bacteriological techniques may not fully explain the higher proportion of atypical bacteria and the lower rate of negative bacteriological studies in our case series. Mean age in our population (63 years) was similar to that in other large studies (range, 64—71 years).[2—5] However, one-third of our patients had major risk factors for infection, usually immunodepression (related to cancer, immunosuppressive therapy and/or long-term steroid therapy). However, comparisons with previous studies are difficult because the criteria used to define immunosuppression vary widely in the literature. Interestingly, serological testing and histopathological analysis of surgical samples yielded a diagnosis of Q fever in one patient and of tuberculosis in another.

Recent reports of high mortality rates[2] are mainly explained by a high proportion of patients with ruptured aneurysms. In a study of 22 patients, who had infected aortic aneurysms treated without aortic resection, mortality was 36% in *Salmonella*-infected patients and 82% in patients infected with other organisms.[13] Surgical excision of the infected aortic aneurysm with *in situ* or extra-anatomic revascularisation remains the reference standard.

In our case series, the difference in postoperative mortality between the extra-anatomic group (66.7%) and the *in situ* group (17.4%) was not statistically significant, perhaps because of our small sample size. The clinical condition of the patient plays a role in the decision to perform extra-anatomic bypass grafting, which may explain why 2 of the 3 patients treated using this procedure died. These two patients were among the four with iliac aneurysms. However, one of them died from a complication that was unrelated to the aneurysm (heart valve detachment). Despite the lack of studies comparing extra-anatomic and *in situ* repair, most authors recommend *in situ* repair whenever feasible. The efficacy of standard Dacron prostheses for *in situ* replacement of primary infected aortic aneurysms seems limited. In the literature, the failure rate ranged from 5% to 30%.[3,4,14,15] The role for rifampin-bonded grafts in the *in situ* repair of primary infected aneurysms, suggested by Gupta et al.[16] in 1996, is still debated. A randomised trial of rifampin-bonded extra-anatomic Dacron grafts failed to demonstrate a clear benefit.[17] In our study, these grafts failed in 1 of 4 patients. Although experimental[18] and clinical[19—21] data suggest that silver-coated grafts may be superior to rifampin-bonded or standard grafts, their role is difficult to assess, as most series mix a limited number of primary infected aortic aneurysms with a large number of prosthetic graft infections. In our case series, silver-coated grafts failed in 2 of 5 patients.

Our experience with endovascular repair of primary infected aorto-iliac aneurysms is limited. A recent review of 47 cases showed that 16% of patients died and 22.9% experienced persistent infection.[22] Most of the recent case series[23—26] found high aneurysm-related mortality rates, as well as high infection-recurrence rates despite prolonged antibiotic therapy. Stent-graft insertion might serve as a bridge towards secondary allograft replacement, as recently suggested by Inoue.[27]

In our experience, early and late complications occurred only after synthetic graft replacement surgery (4/11 patients, included two with a silver-coated graft, one with a rifampin-soaked graft and one with a stentgraft). There were no complications related to autologous vein repair, and the only complication after allogeneic graft surgery was bleeding with no evidence of infection. We therefore recommend the use of autologous veins or allogeneic grafts for *in situ* repair whenever possible.

Conclusion

The bacteriological spectrum of primary infected aorto-iliac aneurysms is wider than previously reported, due to improvements in diagnostic tests and to an increasing number of patients with immunodepression. *In situ* replacement provides the best results. Autologous material and allogeneic grafts should be preferred over synthetic grafts. Endovascular repair should be limited to high-risk patients, in whom it may serve as a bridge towards allogeneic graft replacement.

Conflict of interest/funding

None.

References

1 Alonso M, Caeiro S, Cachaldora J, Segura R. Infected abdominal aortic aneurysm: in situ replacement with cryopreserved arterial homograft. *J Cardiovasc Surg (Torino)* 1997;**38**:371—5.

2 Muller BT, Wegener OR, Grabitz K, Pillny M, Thomas L, Sandmann W. Mycotic aneurysms of the thoracic and abdominal aorta and iliac arteries: experience with anatomic and extra-anatomic repair in 33 cases. *J Vasc Surg* 2001;**33**:106—13.

3 Fichelle JM, Tabet G, Cormier P, Farkas JC, Laurian C, Gigou F, et al. Infected infrarenal aortic aneurysms: when is in situ reconstruction safe? *J Vasc Surg* 1993;**17**:635—45.

4 Oderich GS, Panneton JM, Bower TC, Cherry Jr KJ, Rowland CM, Noel AA, et al. Infected aortic aneurysms: aggressive presentation, complicated early outcome, but durable results. *J Vasc Surg* 2001;**34**:900—8.

5 Hsu RB, Lin FY. Surgical pathology of infected aortic aneurysm and its clinical correlation. *Ann Vasc Surg* 2007;**21**:742—8.

6 Cochennec F, Gazaigne L, Lesprit P, Desgranges P, Allaire E, Becquemin JP. Aortoiliac aneurysms infected by *Campylobacter fetus*. *J Vasc Surg* 2008;**48**:815—20.

7 Canaud L, Marzelle J, Bassinet L, Carrie AS, Desgranges P, Becquemin JP. Tuberculous aneurysms of the abdominal aorta. *J Vasc Surg* 2008;**48**:1012—6.

8 Breton G, Yahiaoui Y, Deforges L, Lebrun A, Michel M, Godeau B. Psoas abscess: an unusual manifestation of Q fever. *Eur J Intern Med* 2007;**18**:66—8.

9 Watine J, Martorell J, Bruna T, Gineston JL, Poirier JL, Lamblin G. In vivo pefloxacin-resistant *Campylobacter fetus* responsible for gastro-intestinal infection and bacteremia associated with arthritis of the hip. *Yonsei Med J* 1995;**36**:202—5.

10 Cabie A, Bouchaud O, Coulaud JP. *Infections à Campylobacter*. *Encyclopédie Médico Chirurgicale*. Paris: Elsevier; 1996.

11 Rapp C, Imbert P, Fabre R, Cavallo JD, Debord T. *Campylobacter fetus* bacteremia and cellulitis complicating a venous access port infection in an HIV infected patient. *Med Mal Infect* 2007;**37**:284—6.

12 Beumer RR, Hazeleger WC. *Listeria monocytogenes*: diagnostic problems. *FEMS Immunol Med Microbiol* 2003;**1**(35):191—7.

13 Hsu RB, Chang CI, Wu IH, Lin FY. Selective medical treatment of infected aneurysms of the aorta in high risk patients. *J Vasc Surg* 2009;**49**:66—70.

14 Pasic M, Carrel T, Vogt M, von Segesser L, Turina M. Treatment of mycotic aneurysm of the aorta and its branches: the location determines the operative technique. *Eur J Vasc Surg* 1992;**6**:419—23.

15 Hsu RB, Lin FY. Infected aneurysm of the thoracic aorta. *J Vasc Surg* 2008;**47**:270—6.

16 Gupta AK, Bandyk DF, Johnson BL. In situ repair of mycotic abdominal aortic aneurysms with rifampin-bonded gelatin-impregnated Dacron grafts: a preliminary case report. *J Vasc Surg* 1996;**24**:472—6.

17 Earnshaw JJ, Whitman B, Heather BP. Two-year results of a randomized controlled trial of rifampicin-bonded extra-anatomic Dacron grafts. *Br J Surg* 2000;**87**:758—9.

18 Schneider F, O'Connor S, Becquemin JP. Efficacy of collagen silver-coated polyester and rifampin-soaked vascular grafts to resist infection from MRSA and *Escherichia coli* in a dog model. *Ann Vasc Surg* 2008;**22**:815—21.

19 Bandyk DF, Novotney ML, Johnson BL, Back MR, Roth SR. Use of rifampin-soaked gelatin-sealed polyester grafts for in situ treatment of primary aortic and vascular prosthetic infections. *J Surg Res* 2001;**95**:44—9.

20 Batt M, Magne JL, Alric P, Muzj A, Ruotolo C, Ljungstrom KG, et al. In situ revascularization with silver-coated polyester grafts to treat aortic infection: early and midterm results. *J Vasc Surg* 2003;**38**:983—9.

21 Totsugawa T, Kuinose M, Yoshitaka H, Tsushima Y, Ishida A, Minami H. Mycotic aortic aneurysm induced by *Klebsiella pneumoniae* successfully treated by in-situ replacement with rifampicin-bonded prosthesis: report of 3 cases. *Circ J* 2007;**71**:1317—20.

22 Kan CD, Lee HL, Yang YJ. Outcome after endovascular stent graft treatment for mycotic aortic aneurysm: a systematic review. *J Vasc Surg* 2007;**46**:906—12.

23 Patel HJ, Williams DM, Upchurch Jr GR, Dasika NL, Eliason JL, Deeb GM. Late outcomes of endovascular aortic repair for the infected thoracic aorta. *Ann Thorac Surg* 2009;**87**:1366—71. discussion 1371—72.

24 Chaikof EL, Mutrie C, Kasirajan K, Milner R, Chen EP, Veeraswamy RK, et al. Endovascular repair for diverse pathologies of the thoracic aorta: an initial decade of experience. *J Am Coll Surg* 2009;**208**:802—16. Discussion 816—18.

25 Clough RE, Black SA, Lyons OT, Zayed HA, Bell RE, Carrell T, et al. Is endovascular repair of mycotic aortic aneurysms a durable treatment option? *Eur J Vasc Endovasc Surg* 2009;**37**:407—12.

26 Sörelius K, Mani K, Björck M, Nyman R, Wanhainen A. Endovascular repair of mycotic aortic aneurysms. *J Vasc Surg* 2009;**50**:269—74.

27 Inoue H, Iguro Y, Yamamoto H, Ueno M, Higashi A, Tao K, et al. Palliative stent-graft insertion followed by an allograft replacement for an infected and ruptured aortic aneurysm. *Ann Thorac Cardiovasc Surg* 2009;**15**:261—4.