LEADING ARTICLE

Infections of the aorta and iliac arteries

Report of 20 years experience in a single centre

Ann. Ital. Chir., 2011; 82: 429-435

Angela Ferrante*, Alessandro Cina**, Vasileios D. Tsiopoulos***, Francesco Snider*

Catholic University of Sacred Heart School of Medicine, "A. Gemelli" University Hospital, Rome, Italy
**Vascular Surgery Unit, Department of Cardiovascular Medicine*
***Radiology Department*
****Cardiac Surgery Unit, Department of Cardiovascular Medicine*

Infections of the aorta and iliac arteries. Report of 20 years experience in a single centre.

AIM: *Retrospective review of aorto-iliac infections in a single vascular surgery center.*
METHODS: *From a retrospective review of their experience in the last 20 years, the Authors analyze a series of 12 cases of aorto-iliac infection. Prognostic factors, surgical options and results are discussed and compared with the literature.*
RESULTS: *Infections of the aorta eventually associated with aneurysmal degeneration are uncommon (less than 3% of all aortic aneurysms) but still a life-threatening condition with high hospital mortality (25%). No statistical evaluation can be drawn from small series; however, early results are apparently influenced by emergency surgery and comorbidities affecting the immune response; in-situ reconstruction is associated with better long-term results (patency 100%, recurrent infection 0%).*
CONCLUSIONS: *In our experience, in situ aortic grafting reconstruction associated with proper antibiotic therapy obtained satisfactory results in terms of mortality and long-term survival. Endovascular treatment can be adopted in critical patients with prohibitive surgical risk.*

KEY WORDS: Aorta and iliac artery infections, Infective aneurysm, Vascular infections

Introduction

Infections of the aorta, eventually associated with aneurysm development, are rare (0.5-2.6%) with higher rates observed in Eastern countries (13%) [1-6]. Only small series are available from the literature, so it is very difficult to identify risk factors for this disease; most patients are aged, with generalized sepsis and serious comorbidities often associated with a depressed immune response.
Hospital mortality rates are high (16-44%) in spite of improvements in imaging, surgical techniques and available antimicrobial therapy; most of deaths are observed in patients with infections by *Salmonella* or *Staphylococcus Aureus*, in ruptured aneurysms and when the suprarenal aorta is affected [1].
This retrospective, single-center study reports early and late results of treatment in 12 patients observed in the last 20 years.

Pervenuto in Redazione Febbraio 2011. Accettato per la pubblicazione Aprile 2011.
Correspondence to: Angela Ferrante MD PhD, Vascular Surgery Unit, Dept. of Cardiovascular Medicine, Policlinico "A. Gemelli" L.go A. Gemelli 1, Rome 00168 Italy (aferrante@rm.unicatt.it)

Patients description

In the last 20 years, 1280 patients were treated in our Unit for aorto-iliac aneurysmal disease; infection of the

aorta or iliac arteries were observed in 12 cases (0.94%) (Table I). They were 9 men and 3 women with mean age of 63.3 years (range 45 - 84); the site of arterial infection was thoracic aorta in 2 cases, suprarenal aorta in 1, infrarenal aorta in 7, external iliac artery in 2.

History revealed in 4 patients a recent event possibly related to vascular infection (arteriography in 1 case, prostatic biopsy in 1 case, acute pyelonephritis in 2); in one case of suprarenal aortic infection with positive cultures for *Cl. Septicum*, a small cancer of the ascending colon was found at endoscopy. Fever, leucocytosis and increased Eritrocyte Sedimentation Rate were found in all cases. All patients with abdominal aorto – iliac infection presented with abdominal pain and pulsatile mass; lumbar pain was complained in one case, in association with aneurysmal rupture into the left iliopsoas muscle and erosion of vertebral body L3. Recurrent Rematemesis was observed in a patient affected by infective aneurysm of the thoracic aorta who developed an aortoesophageal fistula.

In all patients, angio-CT study was performed to confirm diagnosis as well as to obtain useful details for surgical strategy (cranial extension, involvement of visceral vessels and other regional structures). The morphologic and densitometric patterns found resulted specific in 100% of cases: all patients presented saccular aneurysms with polycyclic contour and dishomogenous thrombus while the non-infected aorta resulted in normal ranges; gas bubbles and periaortic fluid collection were also found in 5 of 6 patients with infrarenal aortic infection. Cultures of peripheral blood and/or the arterial wall resulted positive in 10 cases (83.3%), the most common bacterial species found were *Salmonella* and *St. Aureus*; two patients with negative cultures were already on antibiotic therapy when observed but intraoperative findings and histologic appearance suggested an acute suppurative infection. Broad spectrum antibiotics (Imipenem + Teicoplanine) were given in all patients as first choice, and further adjustments were done on the results of coltures; intravenous therapy was maintained for average 2 postoperative weeks. All patients received surgical (open or endovascular) treatment as emergency; two patients were already on oral antibiotic therapy (amoxicillin and ciprofloxacin) resulted uneffective.

Surgical treatment (conventional or endovascular) was offered in all cases. Of 7 patients with abdominal aortic infection, aortic exclusion + abscess drainage and axillobifemoral bypass was performed in our first case; *in situ* reconstruction was performed in the later 6 cases using antibiotic-bound (Rifampicin) dacron graft. Omental flap was always used for additional graft wrapping. In 1 patient with suprarenal aortic infection (Fig.

TABLE I

Case	Age	Sex	SIRS	Site	Blood cultures	Wall cultures	Microbiology	Treatment	Outcome
1	78	f	y	TA	pos	NA	St. Aureus	TEVAR	Dead 2 months (aortoesophageal fistula?)
2	81	m	y	TA	pos	na	E.Coli	TEVAR	Dead 3th POD (endoleak type I, aortoesophageal fistula + recurrent emathemesis)
3	55	F	Y	SAA	Neg	Pos	Cl. Septicum	Homograft	Dead 18 months (acute cardiac failure)
4	45	M	Y	AAA	Pos	Neg	Salmonella	Aortobiiliac graft	Dead 12 months (myocardial infarction)
5	56	M	Y	AAA	Pos	Pos	Salmonella	Axillobifemoral bypass	Alive 8 yrs.
6	71	M	N	AAA	Neg	Neg	None (intraoperative finding)	Aorto-aortic graft	Alive 7 yrs.
7	76	M	Y	AAA	Pos	Pos	St. Aureus	Aortobifemoral graft	Dead 15th POD (rupture of undiagnosed hypogastric aneurysm)
8	63	M	Y	AAA	Neg	Neg	(microabscessual flogosis at hystology)	Aorto-aortic graft	Alive 3 yrs.
9	61	m	n	AAA	Pos	Pos	Salmonella, Enterobacter, E.Coli	Aortobiiliac graft	Alive 2 yrs.
10	84	M	Y	AAA	neg	pos	St. Aureus	Aorto-aortic graft	Dead 19th POD (Pneumonia + MOF)
11	62	f	y	EIA	pos	NA	Salmonella	Femorofemoral bypass	Dead 24 months (Pneumonia+MOF)
12	64	m	y	EIA	pos	Neg	St. Aureus	Femorofemoral bypass	Alive 7 yrs.

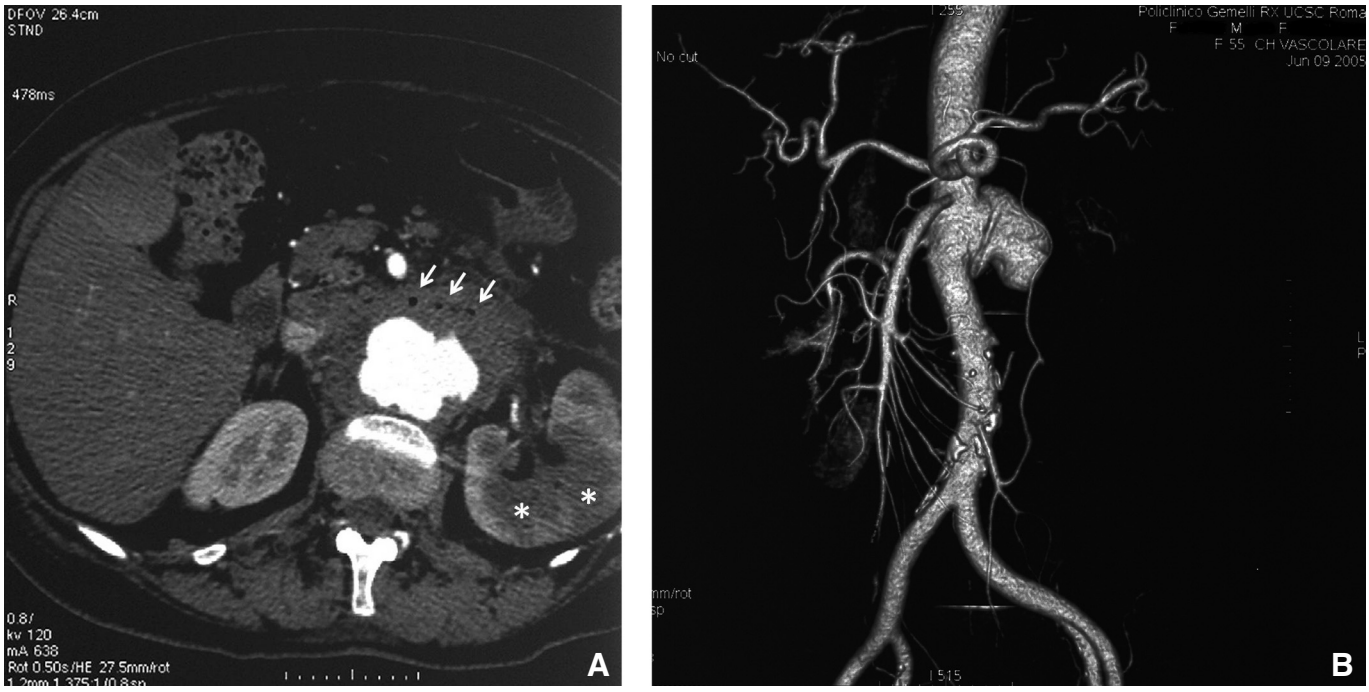

Fig. 1: Post-contrast axial (A) and volume rendering reconstruction (B) in a 55-years old patient with suprarenal infective aneurysm. The aortic lumen is irregular and an asymmetrical periaortic soft tissue mass with air bubbles (arrows) is observed. The left kidney shows multiple hypodense areas of infarction (asterisks) correlated to the involvement of the renal artery by the aneurysm.

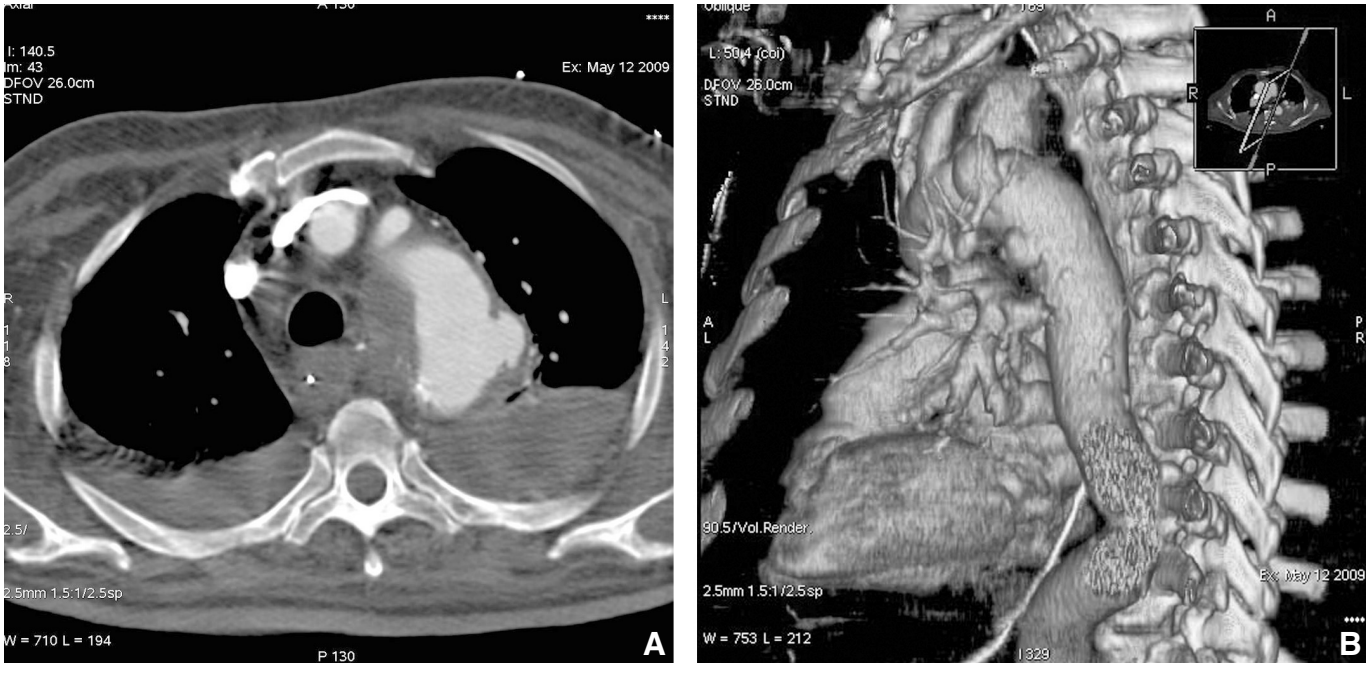

Fig. 2: 3D Volume Rendering oblique sagittal reconstruction (A) in a 81-years old man with infective aneurysms of descending aorta (arrows). The corresponding axial scan (B) shows a saccular focal dilatation of isthmic aorta. Mediastinal and bilateral pleural effusions are also evident. CT findings were consistent with acute contained rupture of infective aneurysm.

1 A,B), a cryopreserved homograft was used for *in situ* aortic reconstruction with reimplantation of the celiac, superior mesenteric and right renal arteries; a left nephrectomy was also necessary due to left renal artery disruption and massive renal infarction.

Two patients with isolated external iliac infective aneurysm were treated by proximal exclusion (ligature or embolisation) and femorofemoral bypass.

Endovascular therapy was chosen as emergency treatment for infection of the thoracic aorta in two patients at pro-

hibitive risk for conventional surgery. One of these patients (Fig. 2) presented in critical conditions with hematemesis and CT scan found an infective aneurysm close to the origin of the left subclavian artery with aortoesophageal fistula. The operative risk was considered too high for open surgery, so the patient underwent TEVAR plus aortic arch debranching; a type I endoleak was observed and unsuccesfully treated by proximal extension. Further endovascular attempts were technically unreliable and he died 2 days later from uncontrollable hematemesis; at autopsy the proximal landing zone resulted infected and weakened as well.

Results

Overall operative mortality was 25% (3 pts., see Table I for detailed causes of death); procedure-specific mortality was 50% after TEVAR, 28.6% after *in situ* reconstruction, and 0% after extra-anatomic revascularization. The patient with suprarenal aortic infection treated by homograft developed postoperative acute renal failure requiring hemodialysis.

At follow-up, the mean survival was 42.2 months; 3 late deaths due to cardiac or respiratory disease were observed at 2, 12, 18 respectively. Late graft infection was observed in 1 case, 15 months after femorofemoral bypass, with fatal outcome due to multiple organ failure at 24 months.

All survivors are in good general conditions; all grafts resulted patent and we did not found late outflow impairments. Intravenous specific antibiotic therapy was given for at least 6 weeks after discharge then shifted to oral therapy for further 3-4 months and suspended in absence of inflammation markers and with negative CT scan.

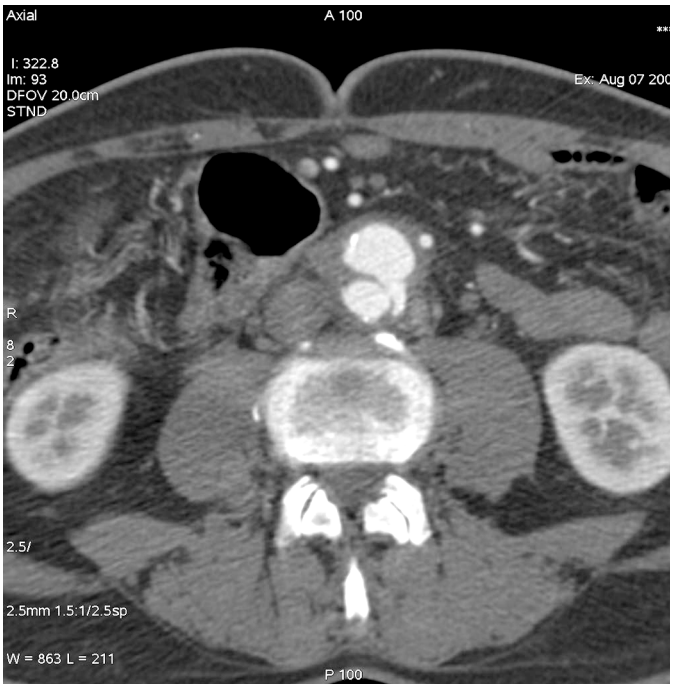

Fig. 3: Post-contrast axial CT scan in a 61-years old man showing an irregular infective aneurysm of the posterior aspect of infrarenal aorta with hypoattenuating material surrounding the aorta and the origin of inferior mesenteric artery.

Discussion

Aorto-iliac infection is a rare disease: in our 20 year experience on 1280 patients treated for aneurysmal disease we observed only 12 cases for an incidence rate of 0.94%, similar to those (0.5-2.5%) reported in other Western countries [3-6]. In Eastern series these rates rise up to 13.3% [2] due to the higher incidence of *Salmonella* infections in the Asian populations.

Several microbial species have been isolated in these patients; the most common are *Salmonella Sp.* (18-74% of cases [2]), *Str. Pneumoniae* [7,8] and *Cl. Septicum* [3,9], this last one showing a significant association with colonic cancer. Sporadic observation of other species have been reported, including *Mycobacteria*, fungi, *Coxiella* and *Lysteria* [4,10,11].

Aortic infection may result from embolizing endocarditis or septicemia with bacterial seeding of the arterial wall; a preexisting atherosclerotic aneurysm may become infected or, more often, aneurysm developes in an artery with normal size. Direct extension of an adjacent infection or via the lymphatics located in an infected area are also been avocated [12]. The natural history of aortic infections is characterized by a fast evolution often complicated by rupture of the arterial wall and perivascular hematoma. The term of "bacterial aortitis" has been proposed to define the rupture occurring in absence of preexisting aneurysm [13,14]; all patients in our experience presented with this particular condition.

Not surprisingly, we found in our experience a prevalence of infections of the abdominal aorta (7 cases), in line with a review of the literature [12] where the femoral artery resulted the most affected site. We observed only 3 cases of infection of the suprarenal – thoracic aorta but they have been reported at consistant rates (45%) in other series [5].

In all cases, we observed the clinical features already described for infective abdominal aortic aneurysms: fever, abdominal and/or back pain, pulsatile abdominal mass and hemodynamic instability when rupture or systemic sepsis occurs. Lesions of the thoracic aorta have been diagnosed only when locoregional complications occurred - like aorto-esophageal or aorto-bronchial fistula.

The most accurate imaging evaluation is obtained by CT scan [2, 16]; pathognomonic findings include gas within the aneurysm, lack of calcifications in the aortic wall, periaortic mass with dyshomogeneous necrotic areas, lob-

ulated or saccular aneurysm of an otherwise normal aorta (Fig.). The rupture is usually contained and resembling a pseudoaneurysm. At serial studies, infective aneurysms may also show a rapid expansion rate.

Intraoperative findings are focal, contained rupture of a thinned and inflamed aortic wall; periaortic adenopathy is common, eventually with colliquative necrosis and purulent collection. Cultures of the aneurysmal wall are usually positive but a microscopic pattern of microabscessual foci can be found also in patients with negative cultures – 2 cases in our experience.

Recently, some Authors focused on the importance of immune status in the clinical evolution and ultimate outcome of these patiens. The SIRS (Systemic Inflammation Response Syndrome) criteria are 1) temperature <37°C or >38°C, 2) heart rate >90 bpm, 3) respiratory rate >20 or pCO2 <32 Torr, and 4) WBC count <4000 or >12000; patients are considered as affected by SIRS when two or more criteria are found. A significant correlation has been described between SIRS and mortality rates [12,17]. Immunosuppression is often found in these patients, either as a diabetes-related condition either resulting from other comorbidities; immunosuppressed patients show more aggressive infections and early aneurysmal rupture, as well as higher postoperative morbidity and mortality rates [5,6]. In our series, 10 patients showed SIRS and 3 dead at 30-days; both residual patients without SIRS are alive at 1 and 7 years, respectively.

Therapeutic options for aortic infective aneurysms are still debated. The goal of ideal treatment should include complete excision of infected tissues and vascular structures as well as blood flow restoration by infection-resistant graft. Essentially two strategies are possible: debridement, aortic interruption and extra-anatomic bypass or *in-situ* reconstruction using antibiotic-bound conventional vascular graft; cryopreserved allografts are also available for direct aortic replacement.

Extra-anatomic revascularization has been proposed to avoid the hazard of placing a vascular graft in a contaminated site with related risks of secondary graft infections; 30-day mortality rates from the literature are 24 – 39%. In some reports on *Salmonella* infections [18], long-term survivals are better than after *in-situ* reconstruction (77% vs. 53%) probably due to high virulence of these infections with increased risk of late complications. We adopted this technique in early phase of our experience on aortic infections (1 case) and in 2 patients with isolated external iliac artery infection. The limited number of patients does not allow any statistic evaluation; the operative mortality (0%) and the good long-term survival may suggest to use this reconstruction in selected cases (iliac lesions) although endovascular solutions now available should be evaluated in the future.

The weak point of extra-anatomic approach is the proximal aortic stump, possibly at risk of late blowout (20%) with catastrophic consequences [1,13,19]. Lower rate of late patency of extra-anatomic bypasses has also been reported [1] with amputation rate of 20-29% but these findings are not confirmed in other experiences [6]. Late graft infections have been observed in 10-20% of cases [1,20]; we had only 1 case in our series (femorofemoral bypass).

In-situ aorto-iliac reconstruction using conventional or antibiotic-bound dacron conduits [21] allows affordable results in terms of early mortality (0 – 13.3%) [1, 2, 24] and long-term patency (86 – 92%) [5,22-24]. Recurrent graft infections have been reported with lower rates (0-10%) in recent studies: this could be also related to the efficacy of antibiotics currently available [1,2,24]. In our practice, we adopted this technique as first choice for infrarenal aortic infections in patients with acceptable surgical risk. Our procedure-specific mortality rates are high if compared with other series, but all our patients were operated in emergency without proper preoperative antibiotic therapy, both conditions with adverse effects on immediate outcome. However, the operative mortality in these patients compares favourably with that observed after surgery for ruptured non-infective aneurysms in our institution (45%, unpublished data). Moreover, late results in terms of patency (100%) and recurrent infection (0%) support our current strategy.

Cryo-preserved allografts have been proposed because of their supposed lower propensity to secondary infections and foreign-body reaction [12, 25-27]. Early mortality rate of 20% has been reported [26] with 55% survival at 5 years. Fresh allografts have been dismissed because of the significant rates of death from graft rupture [26] but it is still undefined, for cryopreserved grafts, the real risk of late occlusion (27%) or aneurysmal degeneration (4-44%) with eventual para-anastomotic disruption [26,28]. Moreover, these allografts could be not easily suitable because of dimensional unfitting or temporary unavailability from the tissue bank. We limited our experience with such graft to one case of *Cl. Septicum* infection of the suprarenal aorta, in order to reduce the risk of secondary graft infection in such a critical location; a late pseudoaneurysm was observed at the site of right renal artery reimplantation.

Endovascular treatment of infective aneurysms has been described in recent years as a new therapeutic option [29-32], particularly in critically ill patients with prohibitive surgical risk. Perioperative mortality rates (9-10%) are quite better than in open surgery patients. In experienced centers, the endovascular approach is safe enough to be used also as a bridge procedure in selected cases (aorto-duodenal fistula with active bleeding, aortic arch infection, aorto-esophageal or aorto-bronchial fistula) with acceptable mortality and morbidity [24,33,34]. However, it is questionable to compare the better early results of endovascular treatment with those of conventional surgery because of substantial differences in criteria for patients selection, single-center experience with both

therapeutic options and number of cases treated. Moreover, endovascular approach does not allow local debridement nor drainage of fluid collections; cultures from the arterial wall are unavailable and this could impair a proper antibiotic therapy. While mid-term results are encouraging, longer follow-up and multicentric perspective studies are still required; however, if we consider the very poor results of medical treatment alone [35] with in-hospital mortality as high as 50% and 1-year survival even worse, it seems reasonable and ethically correct to attempt endovascular treatment in all patients considered at prohibitive risk for open surgery.

The optimal duration of postoperative antibiotic therapy is not well established; some authors advocate lifelong therapy, particularly in *Salmonella* infections and following *in–situ* reconstruction [22,24,36]. However, most reports including our present series suggest that specific intravenous antibiotics should be given for at least 4-6 weeks and prolonged for the next 3-6 months, then suspended if inflammation markers and local conditions evaluated by CT scan result normal.

Conclusions

Prospective and randomized studies on aortic infections are unavailable, thus single centre results cannot be conclusive. In our limited experience, *in-situ* reconstruction has been done whenever possible in patients with good prognosis and acceptable surgical risk, with satisfactory long-term and infection-free survival. Extra-anatomical reconstruction has been done in our first case of aortic infection and thereafter reserved to patients with infection limited to external iliac artery. Antibiotic therapy should be modulated on the results of CT scan and evaluation of flogosis indexes; however, a lifelong follow-up is mandatory. Our endovascular experience is recent and limited but it looks promising in aortic arch infections where open surgery could be a prohibitive challenge in critical patients with serious comorbidities.

Riassunto

Le infezioni dell'aorta e delle arterie iliache costituiscono una condizione, seppur infrequente (3% dei casi), potenzialmente letale e ancora oggi gravata da elevati tassi (25%) di mortalità operatoria. L'evoluzione della patologia, accompagnata o meno da degenerazione aneurismatica, è rapida ed esita nella rottura del segmento interessato. La limitata numerosità delle esperienze riportate in Letteratura non consente un'analisi statistica attendibile per quanto riguarda fattori di rischio e condizioni predisponenti; tuttavia, sembra indicativo il riscontro di comorbilità che riducono l'immunocompetenza del paziente esponendolo a un aumentato rischio infettivo. Le possibilità di trattamento chirurgico convenzionale consistono nella rivascolarizzazione extra-anatomica o nella ricostruzione vascolare diretta con protesi sintetica o homograft; recentemente è stato proposto anche in questo campo l'impiego di endoprotesi. Gli Autori presentano la loro esperienza su 12 casi osservati negli ultimi 20 anni e, anche sulla base della Letteratura disponibile, espongono le principali problematiche e i risultati delle diverse opzioni terapeutiche.

References

1) Hsu RB, Chen RJ, Wang SS, Chu SH: *Infected aortic aneurysms: Clinical outcome and risk factor analysis.* J Vasc Surg, 2004; 40:30-5.

2) Luo CY, Ko WC, Kan CD, Lin PY, Yang YJ: *In situ reconstruction of septic aortic pseudoaneurysm due to Salmonella or Streptococcus microbial aortitis: Long-term follow-up.* J Vasc Surg, 2003; 38:975-82.

3) Seder CW, Kramer M, Long G, Uzieblo MR, Shanley CJ, Bove P: *Clostridium septicum aortitis: Report of two cases and review of the literature.* JVasc Surg, 2009; 49:1304-9.

4) Miller DV, Oderich GS, Aubry M-C, Panneton JM, Edwards WD: *Surgical pathology of infected aneurysms of the descending thoracic and abdominal aorta: Clinicopathologic correlations in 29 cases (1976 to 1999).* Hum Pathol, 2004; 35:1112-120.

5) Oderich GS, Panneton JM, Bower TC, Cherry 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.

6) Woon CYL, Sebastian MG, Tay KH, Tan SG: *Extra-anatomic revascularization and aortic exclusion for mycotic aneurysms of the infrarenal aorta and iliac arteries in an Asian population.* Am J Surg, 2008; 195:66-72.

7) Bronze MS, Shirwany A, Corbett C, Shaberg DL: *Infectious aortitis: An uncommon manifestation of infection with Streptococcus Pneumoniae.* Am J Med, 1999; 107:627-30.

8) Stephens CT, Pounds LL, Killewich LA: *Rupture of a nonaneurysmal aorta secondary to Staphylococcus aortitis – A case report and review of the literature.* Angiology, 2006; 57:506-12.

9) Mohamed HK, Elliott BM, Brothers TE, Robison JG: *Suprarenal Clostridium Septicum aortitis with rupture and simultaneous colon cancer.* Ann Vasc Surg, 2006; 20:825-29.

10) Sessa C, Vokkri L, Porcu P, Maurin M, Stahl JP, Magne J-L: *Abdominal aortic aneurysm and Coxiella Burnetii infection: Report of three cases and review of the literature.* J Vasc Surg, 2005; 42:153-58.

11) Godderis K, Daenens K, Moulin-Romsee G, Blockmans D: *Chronic-contained rupture of an infected aneurysm of the abdominal aorta due to Lysteria Monocytogenes.* Neth J Med, 2006; 64:85-87.

12) McCready RA, Bryant MA, Divelbiss JL, Chess BA, Chitwood RW, Paget DS: *Arterial infections in the new millenium: An old problem revisited.* Ann Vasc Surg 2006; 20:590-95.

13) Ihaya A, Chiba Y, Kimura T, Morioka K, Uesaka T: *Surgical outcome of infectious aneurysm of the abdominal aorta with or without SIRS.* Cardiovasc Surg, 2001; 9:436-40.

14) Oz MC, Brener BJ, Buda JA, Todd G, Brenner RW, Goldenkranz RJ, et al.: *A ten-year experience with bacterial aortitis.* J Vasc Surg, 1989; 10:439-49.

15) Narang A, Rathlev NK: *Non-aneurysmal infectious aortitis: A case report.* J Emerg Med, 2007; 32:359-63.

16) Brown SL, Busuttil RW, Baker JD, Machleder HI, Moore WS, Barker WF: *Bacteriologic and surgical determinants of survival in patients with mycotic aneurysms.* J Vasc Surg, 1984; 1:541-47.

17) Muller BT, Wegener OR, Grabitz K, et al: *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.

18) Soravia-Durand VA, Loo VG, Salit IE: *Aortitis due to Salmonella: report of 10 cases and comprehensive review of the literature.* Clin Infect Dis, 1999; 29:862-68.

19) Bacourt F, Koskas F, and Association Universitaire de Recherche en Chirurgie: *Axillo-femoral bypass and aortic exclusion for vascular septic lesions: A multicentric retrospective study of 98 cases.* Ann Vasc Surg, 1992; 6:119-26.

20) Yeager RA, TaylorLM, Moneta GL, Edwards JM, Nicoloff AD, McConnel DB et al.: *Improved results with conventional management of infrarenal aortic infection.* J Vasc Surg, 1999; 30:76-83.

21) Bandyk DF, Novorney ML, Back MR, Johnson BL, Schmacht DC: *Expanded application of in situ replacement for prosthetic graft infection.* J Vasc Surg, 2001; 34:411-19.

22) Chan FY, Crawford ES, Coselli JS, Safi HJ, Williams TW Jr.: *In situ prosthetic graft replacement for mycotic aneurysm of the aorta.* Ann Thorac Surg, 1989; 47:193-203.

23) Hsu RB, Tsay YG, Wang SS, Chu SH: *Surgical treatment for primary infected aneurysms of the descending thoracic aorta, abdominal aorta, and iliac arteries.* J Vasc Surg, 2002; 36:746-50.

24) Ting ACW, Cheng SWK, Ho P, Poon JTC, Hsu JHL: *Surgical treatment of infected aneurysms and pseudoaneurysms of the thoracic and abdominal aorta.* Am J Surg, 2005; 189:150-54.

25) Noel AA, Glowiczki P, Cherry KJ, Safi H, Goldstone J, Morasch MD, et al.: *Abdominal aortic reconstruction in infected fields: Early results of the United States Cryopreserved Aortic Allograft Registry.* J Vasc Surg, 2002; 35:847-52.

26) Kieffer E, Gomes D, Chiche L, Fléron M-H, Koskas F, Bahnini A: *Allograft replacement for infrarenal aortic graft infection: Early and late results in 179 patients.* J Vasc Surg, 2004; 39:1009-17.

27) Brown KE, Heyer K, Rodriguez H, Eskandari MK, Pearce WH, Morasch MD: *Arterial reconstruction with cryopreserved human allografts in the setting of infection: A single-center experience with midterm follow-up.* J Vasc Surg, 2009; 49:660-66.

28) Leséche G, Castier Y, Petit MD, Bertrand P, Kitzis M, Mussot S et al.: *Long term results of cryopreserved arterial allograft reconstruction in infected prosthetic grafts and mycotic aneurysms of the abdominal aorta.* J Vasc Surg, 2001; 34:616-22.

29) Sörelius K, Mani K, Björck M, Nyman R, Wanhaimen A: *Endovascular repair of mycotic aortic aneurysms.* J Vasc Surg, 2009; 50:269-74.

30) Razavi MK, Razavi MD: *Stent-graft treatment of mycotic aneurysms: A review of the current literature.* J Vasc Interv Radiol, 2008; 19:51-56.

31) Kan CD, Lee HL, Yang YJ: *Outcome after endovascular stent graft treatment for mycotic aortic aneurysm: A systemic review.* J Vasc Surg, 2007; 46:906-12.

32) Smith JJ, Taylor PR: *Endovascular treatment of mycotic aneurysms of the thoracic and abdominal aorta: The need for level I evidence.* EJVES, 2004; 27:569-70.

33) Chan YC, Morales JP, Taylor PR: *The management of mycotic aortic aneurysm: Is there a role for endoluminal treatment?* Acta Chir Belg, 2005; 105:580-87.

34) Van Dorn RC, Reekers J, de Mol BA, Obertop H, Balm R: *Aortoesophageal fistula secondary to mycotic thoracic aorta aneurysm: Endovascular repair and transhiatal esophagectomy.* J Endovasc Ther, 2002; 9:212-17.

35) 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.

36) Hollier LH, Money SR, Creely B, Bower TC, Kazmier FJ: *Direct replacement of mycotic thoracoabdominal aneurysms.* J Vasc Surg, 1993; 18:477-85.