Eur J Vasc Endovasc Surg 14 (Supplement A), 47–52 (1997)

Conservative Treatment of Aortic Graft Infection

G. R. Pistolese*, A. Ippoliti, I. Tuccimei and A. Lorido

Department of Vascular Surgery, University of Rome, "Tor Vergata", Italy

Introduction

An infected prosthetic graft of the aorta is still among the most unwelcome and challenging complications that the vascular surgeon has to tackle. Despite being uncommon, the reported incidence ranging from 1 to 6%, aortic prosthetic graft infections invariably portend high mortality and significant risk of limb loss.

The conventional approach comprises total excision of the infected prosthetic graft, oversewing of the aortic stump and lower-limb revascularisation by extra-anatomic bypass. Although recent series show that this management has improved mortality and morbidity rates, it remains far from ideal.[1–7]

When knowledge of the natural history of graft infections was scarce, conservative management used to be the procedure of choice. It has now been largely abandoned due to unsatisfactory results. Yet in selected cases, notably patients with high surgical risks, a conservative approach may still be a valid option. Conservative treatment consists of surgical debridement, drainage, and local antibiotic or povidone-iodine irrigation, with complete graft preservation or otherwise percutaneous computed tomography (CT)-guided drainage with local and systemic antibiotic therapy. In specific circumstances both strategies yield encouraging results.[8–15]

In this study we have evaluated the few published reports and our own experience with patients treated conservatively for infected aortic prosthetic grafts. Our aim was to determine whether conservative treatment should be reserved for patients at high operative risk or might be a useful initial therapeutic approach for all patients.

* Please address all correspondence to: G. R. Pistolese, Department of Vascular Surgery, University of Rome, "Tor Vergata", S. Eugenio Hospital, Piazzale dell'Umanesimo 10, 00144, Roma EUR, Italy.

Case Reports

Case 1

A 76-year-old man with a rectal carcinoma underwent elective resection of a symptomatic aortoiliac aneurysm in August 1989. The aorta was reconstructed by inserting a knitted Dacron bifurcated graft extending from the infrarenal aorta to the right external iliac artery and to the left common femoral artery, under systemic antibiotic coverage (cefotaxime 2 g i.v. and vancomycin 500 mg i.v. on induction of anaesthesia). Recovery was uneventful. One month later the patient was readmitted for treatment of the rectal tumour. He had no symptoms or signs of aortic graft infection. At operation a perigraft fluid collection was noted. After evacuation of the fluid and povidone-iodine irrigation two drainage tubes were placed along the graft. The rectum was resected (Hartmann procedure). Initial cultures isolated a pure growth of *Enterobacter cloacae* and the patient received treatment with i.v. piperacillin (3 g three times daily), amikacin (500 mg every 12 h) and metronidazole (500 mg three times daily). Antibiotic solution (gentamycin) was instilled through the drainage tubes until the effluent became sterile. After a 24-day course of drainage with local and systemic antibiotic treatment the patient was discharged on a regimen of oral systemic antibiotic therapy (ofloxacin). He remained asymptomatic for 2 years before dying of non graft-related causes.

Case 2

In April 1994 a 76-year-old man underwent elective repair of an abdominal aortoiliac aneurysm and reconstruction with a knitted Dacron bifurcated graft, under systemic antibiotic coverage (cefotaxime 2 g i.v. and vancomycin 500 mg i.v. on induction of anaesthesia). Postoperative recovery was uneventful.

1078–5884/97/SA0047+06 $12.00/0

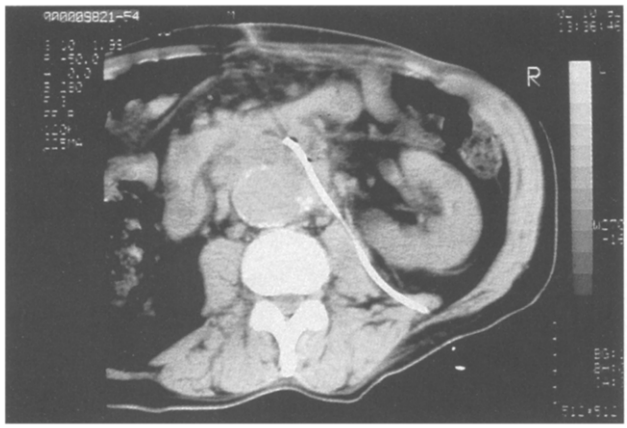

Fig. 1. (Case 3) Sump drain catheter placed percutaneously into the periprosthetic fluid collection.

Fig. 2. (Case 3) Follow-up CT scan after 42 months: absence of signs of recurrent graft infection.

Three weeks after discharge the patient was readmitted because of fever (up to 39 °C), malaise, pain in the left iliac fossa and acute abdominal symptoms. Laboratory findings on admission included leukocytosis (12 800) and an erythrocyte sedimentation rate of 115 mm/h. An ultrasound scan showed a fluid collection in the left iliac fossa and a CT scan documented a large abscess (maximum diameter 10 cm) surrounding the left iliac graft limb and the psoas muscle. Exploratory laparotomy showed a perigraft fluid collection. The fluid was drained and two irrigation tubes were inserted along the graft. Cultures of purulent material isolated *Escherichia coli*. The graft was irrigated with antibiotic solution (cefotaxime) injected through the drainage tubes and the patient received concomitant antibiotic therapy with i.v. amikacin (500 mg twice daily) and cefotaxime (2 g three times daily). Drainage tubes were removed 20 days later, when the effluent became sterile and CT-scan showed no perigraft fluid collection. The patient was discharged on a regimen of oral antibiotic therapy (ciprofloxacin), which he continued for 3 months. A follow-up CT-scan 18 months after surgery revealed no further signs of graft infection.

Fig. 3. (Case 4) CT scan documented a retroperitoneal fluid collection around the graft.

Fig. 4. (Case 4) Follow-up CT scan after 8 months from CT-guided percutaneous drainage: absence of signs of recurrent graft infection.

Case 3

A 68-year-old man underwent elective repair of an abdominal aortic aneurysm, under systemic antibiotic coverage (cefotaxime 2 g i.v. and vancomycin 500 mg i.v. on induction of anaesthesia), in July 1992. The aorta was reconstructed using a straight knitted Dacron graft with the proximal anastomosis just below the renal arteries. No postoperative complications occurred. Two months later the patient was readmitted because of intermittent-remittent fever and tachycardia of 2 days' duration. Temperature was 38 °C, white cell blood count was 12 000 and he had an increased erythrocyte sedimentation rate. The abdomen was non-tender and femoral pulses were present bilaterally. Real-time ultrasound of the pelvis showed a

fluid collection around the graft and a CT scan of the abdomen and pelvis showed a non-homogeneous retroperitoneal fluid collection, surrounding the entire graft from the proximal anastomosis to the aortic bifurcation. A leukocyte-labelled technetium 99-m hexametazime scan showed increased radiotracer uptake in the graft region. Because of the foreseeable technical difficulty in undertaking a conventional operation (proximal anastomosis just below the origin of the renal arteries) we began CT-guided percutaneous drainage. Initial cultures of the aspirate (60 cm^3) showed a pure growth of *Staphylococcus epidermidis*. Antibiotic solution (rifampicin) was injected through the drainage tube, around the graft. After a 3-week course of drainage and irrigation, two consecutive cultures yielded negative results and the drainage tube was removed. The patient was discharged on a regimen of oral antibiotic therapy (600 mg clindamycin daily), which he continued for 6 months. Follow-up CT scans 1 and 3 months after drainage showed no perigraft fluid collections. The last follow-up CT scan, at 42 months, still showed nothing abnormal around the aortic graft.

Case 4

An 81-year-old man, with heart disease, bilateral chronic arteriopathy and diverticulosis, underwent elective repair of an abdominal aortic aneurysm (maximum diameter 8 cm) in June 1994, with a knitted Dacron bifurcated graft extending from the infrarenal aorta to the bilateral common iliac arteries. The operation was performed under systemic antibiotic coverage (cefotaxime 2 g i.v. and vancomycin 500 mg i.v. on induction of anaesthesia). The patient had an uneventful postoperative course. Three weeks after discharge he had to be admitted urgently because of fever, vomiting, and a tender swelling in the left iliac fossa. Laboratory findings included a white cell blood count of 20 000 and an increased erythrocyte sedimentation rate. A CT scan showed evidence of a fluid collection around the aortic bifurcation and the left psoas muscle. The patient received amikacin (500 mg i.v. every 12 h) and cefotaxime (2 g i.v. three times daily). CT-guided percutaneous drainage yielded 1200 ml of purulent material. Cultures grew *Escherichia coli*. Antibiotic solution (cefotaxime in sterile saline) was infused through the drainage catheter. Local antibiotic therapy was continued for 21 days, two cultures resulted sterile and drainage was removed. A follow-up CT scan showed that the perigraft fluid had disappeared. On postoperative day 23 the patient was discharged from the hospital and continued taking oral antibiotic (500 mg ampicillin daily). He remained asymptomatic for 10 months when he died suddenly of liver failure. Post-mortem examination showed no evidence of prosthetic graft infection.

Discussion

Conventional treatment of aortic graft infection consists of total graft excision and revascularisation, as graft excision alone is rarely feasible. This treatment option has become the "gold standard" in the management of aortic graft infection, but results remain far from ideal.[6,7,16] Yet its critics emphasise the risk of aortic stump dehiscence, the risk of re-infection of the extra-anatomic bypass used for revascularisation, and its poor long-term patency.[2,3,17] As alternative approaches to conventional management in certain well-defined circumstances, many recent reports recommend *in situ* replacement or conservative treatment.[14,18–20] *In situ* reconstruction avoids the potential risk of aortic stump blow-out and results in a lower incidence of limb loss. Its main drawback is the risk of severe complications owing to recurrent infection.[5,19,21,22]

Reports published in the 1960s and 1970s commonly described patients with aortic graft infections treated conservatively. Surgeons' reluctance to remove infected prostheses in the absence of overwhelming indications reflected their concern that removing a functioning graft could result in severe distal ischaemia and even limb loss. At that time methods for extra-anatomic reconstruction around the infected sites had not been well developed.[23] Because it resulted in unsatisfactory mortality and reinfection rates, conservative treatment eventually became reserved almost exclusively for patients considered at high risk for conventional surgery.

Nevertheless, a deeper analysis of such results – in cases with complications and in those without them – allows the identification of a group of patients who may benefit from conservative treatment. Support for the importance of secondary complications in surgical failure came from our review of published reports of patients with aortic grafts treated conservatively (Table 1). In patients with graft-enteric erosions, fistula, bleeding or pseudoaneurysms, in terms of operative mortality (76.6%) or persisting infections eventually necessitating radical surgery (6.4%), conservative treatment achieved wholly unacceptable results. During postoperative follow-up ranging from 2 to 24 months, only 17% of the 94 patients described could reasonably

Table 1. Conservative treatment of aortic graft infection: difference of results in presence of secondary complications. Literature review.

	No patients	Recovery	Excis. treat.	Mortality
Cases of aortic graft infection with complications*	94	17%	6.4%	76.6%
Cases of aortic graft infection without complications†	43	65.1%	23.3%	18.6%

*Sharf'59, Hagland'59, MGH'59, Boyd'59, Cordell'60, Thistlewaite'60, Pollock'61, Deweese'62, Javid'62, Long'62, Humpries'63, Ferris'65, Van De Water'65, Wiernan'66, Donovan'67, Sheill'69, Schramel'71, Szilagyi'72, Tobias'73, Elliot'74, Brenner'74, Ray'76, Becker'76, Buchbinder'80, Perdue'80, Puglia'80, Puppala'80, O'Mara'81, O'Hara'86, Thomas'86, Higgins'90.
†Van De Water'65, Conn'70, Szilagyi'72, Bouhoutsos'74, Christenson'77, Liekweg'77, Crawford'77, Yashar'78, Knight'83, Almgren'85, Edwards'88, Francois'91, Wakefield'94, Morris'94.

consider themselves cured.[21,24-54] Patients without secondary complications fared better. Of the 43 patients considered, with follow-up ranging from 21 to 61 months, 65.1% recovered without complications and 23.3% had reinfections that responded to conventional treatment. Overall mortality, including patients in whom persisting infections necessitated further surgery, reached 18.6%.[8,9,13,14,37,42,55-62]

Our review and personal experience suggests that, whereas patients with secondary complications undoubtedly need conventional treatment, patients without secondary complications — not only those at high surgical risk – could undergo conservative procedures.

The contraindications to conservative management include anastomotic complications, systemic sepsis, septic peripheral embolisation (a sign of severe bacterial colonisation of the graft) and all immune system disorders.[63] Patients with uncomplicated graft infections without general or local contraindications seem to respond well to an initial conservative approach using percutaneous CT-guided or ultrasound-guided drainage with concomitant high-dose local and systemic antibiotic therapy. More frequent use of conservative treatment might lead to earlier diagnosis of infections, before secondary complications develop.

CT-guided percutaneous drainage is a relatively simple procedure. It is done under local anaesthesia and is far less traumatic for the patient than surgical drainage. After an initial scan to assess the ideal puncture site and patient's position, a 12-French dual-lumen catheter (Van Sonnemberg type) is inserted percutaneously. The cavity is drained and, as long as the catheter remains in place, samples of drainage fluid are repeatedly cultured to isolate organisms for antibiotic susceptibility testing. An antibiotic solution is instilled locally into the cavity through the catheter once or more a day.[12] Drainage catheters are left in place until the drain yields sterile fluid and CT scans no longer show a retroperitoneal fluid collection. Systemic antibiotic therapy, selected from susceptibility testing, is administered intravenously for 4–6 weeks; after this period patients must continue long-term oral antibiotic therapy (from 3 months to life-long).

Although CT-guided drainage is relatively widely used in clinical practice, especially in diagnosis, few published reports have addressed its therapeutic uses. Tobin reported one patient in whom an aortofemoral bypass graft infection developed 1 month after surgery and responded to CT-guided percutaneous drainage.[10] Matley *et al.* also described one patient who had a thoracoabdominal aortic graft infection with a good outcome after conservative management.[12] Svensson noted the diagnostic and therapeutic usefulness of percutaneous catheter drainage in patients with aortic graft infections at high operative risk for redo surgery.[15] Hollier also recommended this approach as a valid alternative to conventional treatment in selected patients.[64]

As well as being indicated in high surgical risk patients, we believe that CT-guided percutaneous drainage can be used as a first step in treating aortic graft infection provided that infection is diagnosed early, before complications have developed. CT-guided drainage is indicated only for infections caused by less virulent organisms with high sensitivity to antibiotic therapy and is contraindicated in all patients with immune system impairment.

Conclusions

At present the preferred treatment of aortic graft infection is total prosthetic graft excision, with lower limb revascularisation achieved by an extra-anatomic bypass through uninfected tissue planes. Conservative treatment by surgical drainage is an alternative approach, but is a compromise solution that has few advantages. In high surgical risk patients without complications, CT-guided percutaneous drainage may be a safer alternative than routine aggressive excision. It also helps diagnosis by allowing detection of the graft infection in bacteriological cultures and antibiotic sensitivity testing. We suggest that it be used as the initial approach in all patients, who have an early diagnosis of aortic graft infections without complications. It offers a good chance of recovery or improvement by reducing bacterial concentrations before planning graft excision. Future experience will verify

the real value of percutaneous catheter treatment as a first step for managing patients with non-complicated aortic graft infections.

References

1 Schmitt DD, Seabrook GR, Bandyk DF, Towne JB. Graft excision and extraanatomic revascularization: the treatment of choice for the septic aortic prosthesis. *J Cardiovasc Surg* 1990; **31**: 327–332.
2 Yeager RA, Moneta GL, Taylor LM *et al.* Improving survival and limb salvage in patients with aortic graft infection. *Am J Surg* 1990; **159**: 466–469.
3 Quinones-Baldrich WJ, Hernandez JJ, Moore WS. Long-term results following surgical management of aortic graft infection. *Arch Surg* 1991; **126**: 507–511.
4 Ricotta JJ, Faggioli GL, Stella A *et al.* Total excision and extra-anatomic bypass for aortic graft infection. *Am J Surg* 1991; **162**: 145–149.
5 Bacourt F, Koskas F, French Univ Assn for Research in Surgery. Axillobifemoral bypass and aortic exclusion for vascular septic lesions: a multicenter retrospective study of 98 cases. *Ann Vasc Surg* 1992; **6**: 119–126.
6 Lehnert T, Gruber HP, Maeder N, Allenberg JR. Management of primary aortic graft infection by extra-anatomic bypass reconstruction. *Eur J Vasc Surg* 1993; **7**: 301–307.
7 Sharp WJ, Hoballah JJ, Mohan CR *et al.* The management of the infected aortic prosthesis: A current decade of experience. *J Vasc Surg* 1994; **19**: 844–850.
8 Knight CJ, Farnell MB, Hollier LH. Treatment of aortic graft infection with povidone-iodine irrigation. *Mayo Clin Proc* 1983; **58**: 472–475.
9 Almgren B, Eriksson I. Local treatment of infected arterial grafts. *Acta Chir Scand Suppl* 1985; **529**: 91–94.
10 Tobin KD. Aortobifemoral perigraft abscess: treatment by percutaneous catheter drainage. *J Vasc Surg* 1988; **8**: 339–343.
11 Quick CR, Vassallo DJ, Colin JF, Heddle RM. Conservative treatment of major aortic graft infection. *Eur J Vasc Surg* 1990; **4**: 63–67.
12 Matley PJ, Beningfield SJ, Lourens S, Immelman EJ. Successfully treatment of infected thoracoabdominal aortic graft by percutaneous catheter drainage. *J Vasc Surg* 1991; **13**: 513–551.
13 Francois F, Thevenet A. Traitement conservateur d'une infection de prothese aortique par irrigation-lavage. *Ann Chir Vasc* 1991; **5**: 199–201.
14 Morris GE, Friend PJ, Vassallo DJ, Farrington M, Leapman S, Quick CRG. Antibiotic irrigation and conservative surgery for major aortic graft infection. *J Vasc Surg* 1994; **20**: 88–95.
15 Svensson LG. Thoracoabdominal graft infections. In: Calligaro KD, Veith FJ, eds. *Management of Infected Arterial Grafts*. St. Louis, Missouri: QMP Inc, 1994: 65–81.
16 Curl GR, Ricotta JJ. Total prosthetic graft excision and extra-anatomic bypass. In: Calligaro KD, Veith FJ, eds. *Management of Infected Arterial Grafts*. St. Louis, Missouri: QMP Inc, 1994: 82–94.
17 Reilly LM, Ehrenfeld WK, Stoney RJ. Delayed aortic prosthetic reconstruction after removal of an infected graft. *Am J Surg* 1984; **148**: 234–239.
18 Calligaro KD, Veith FJ, Gupta SK *et al.* A modified method for management of prosthetic graft infections involving an anastomosis to the common femoral artery. *J Vasc Surg* 1990; **11**: 485–492.
19 Bandyk DF, Bergamini TM, Kinney EV, Seabrook G, Towne JB. In situ replacement of vascular prostheses infected by bacterial biofilms. *J Vasc Surg* 1991; **13**: 575–583.
20 Kieffer E, Bahnini A, Koskas F, Ruotolo C, Le Blevec D, Plissonier D. In situ allograft replacement of infected infrarenal aortic prosthetic grafts: results in forty-three patients. *J Vasc Surg* 1993; **17**: 349–356.
21 Thomas WEG, Baird RN. Secondary aortoenteric fistulae: towards a more conservative approach. *Br J Surg* 1986; **73**: 875–878.
22 Walker WE, Cooley DA, Duncan JM, Hallman GL, Ott DA, Reul GJ. The management of aortoduodenal fistula by in situ replacement of the infected abdominal aortic graft. *Ann Surg* 1987; **205**: 727–732.
23 Goldstone J, Moore WS. Infection in vascular surgery: clinical manifestations and surgical management. *Am J Surg* 1974; **128**: 225–234.
24 Sharf AG, Acker ED. Surgical intervention in ruptured and thrombosed aortic homografts. *Arch Surg* 1959; **78**: 67–69.
25 Hagland L, Sweetman W, Wise R. Rupture of an abdominal aortic homograft with ileal fistula. *Am J Surg* 1959; **98**: 746–748.
26 Case records of the Massachusetts General Hospital. *N Engl J Med* 1959; **261**: 12–24, 1339–1341.
27 Case records of the Massachusetts General Hospital (case 45282). *N Engl J Med* 1959; **261**: 292.
28 Boyd DP, Pastel H. Results of treatment of aneurysm of abdominal aorta. *Postgrad Med* 1959; **25**: 238–242.
29 Cordell AR, Wright RH, Johnston FR. Gastrointestinal hemorrhage after abdominal aortic operations. *Surgery* 1960; **48**: 997–999.
30 Thistlewaite JR. Spontaneous arteriovenous fistula between abdominal aorta and vena cava. *Arch Surg* 1960; **81**: 61–63.
31 Pollock AV, Pratt D, Smiddy FG. Aortic homograft replacement: a sequel. *Ann Surg* 1961; **153**: 472–476.
32 Deweese MS, Fry WJ. Small bowel erosion following aortic resection. *JAMA* 1962; **179**: 882–884.
33 Javid H, Julian OC, Dye WS, Hunter JA. Complications of abdominal aortic grafts. *Arch Surg* 1962; **85**: 142–153.
34 Long L, Hunter J, Dye WS. Migration of aortic prosthesis into the duodenum. *Ann Surg* 1962; **157**: 560–565.
35 Humphries AW, Young JW, DeWolfe VG, LeFevre FA. Complications of abdominal aortic surgery: I: aortoenteric fistulas. *Arch Surg* 1963; **86**: 43.
36 Ferris EJ, Koltay SMR, Sciammas FD. Abdominal aortic and iliac graft fistulae: unusual roentgenologic findings. *Am J Roentgenol Radiother Nucl Med* 1965; **94**: 416–418.
37 Vandewater JM, Gaal PG. Management of patients with infected vascular prosthesis. *Am Surg* 1965; **31**: 6511–6518.
38 Wierman WH, Strahan RW, Spencer JR. Small bowel erosion by synthetic aortic grafts. *Am J Surg* 1966; **112**: 791.
39 Donovan TJ, Bucknam CA. Aortoenteric fistula. *Arch Surg* 1967; **95**: 810–818.
40 Sheil AGR, Reese TS, Little JM, Coupland AE, Loewenthal J. Aortointestinal fistulas following operation on the abdominal aortic and iliac arteries. *Br J Surg* 1969; **53**: 840–842.
41 Schramel A, Weisz GM, Erlik D. Gastrointestinal bleeding due to arterioenteric fistula. *Digestion* 1971; **4**: 103–108.
42 Szilagyi DE, Smith RF, Elliott JP, Vrandecic MP. Infection in arterial reconstruction with synthetic grafts. *Ann Surg* 1972; **176**: 321–333.
43 Tobias JA, Daicoff GR. Aortogastric and aortoileal fistulas repaired by direct suture. *Arch Surg* 1973; **107**: 909–912.
44 Elliott JP, Smith RF, Szilagyi DE. Aortro-enteric and paraprosthetic fistulas. *Arch Surg* 1974; **108**: 479–490.
45 Brenner WI, Richman A, Reed GF. Roofpatch repair of an aortoduodenal fistula resulting from suture line failure in an aortic prosthesis. *Am J Surg* 1974; **127**: 762–764.
46 Ray R, McAfee RE, Hiebert CA, Hall WJ. Aortoduodenal fistula: primary repair with saphenous vein patch graft. *JAMA* 1976; **236**: 2423–2425.
47 Becker RM, Blundell PE. Infected aortic bifurcation grafts: experience with fourteen patients. *Surgery* 1976; **80**: 544–549.
48 Buchbinder D, Leather R, Shah D, Karmody A. Pathologic interactions between prosthetic aortic grafts and the gastrointestinal tract. *Am J Surg* 1980; **140**: 192–196.
49 Perdue GD, Smith RG, Ansley JD, Constantino MJ. Impending aortoenteric hemorrhage: the effect of early recognition on improved outcome. *Ann Surg* 1980; **192**: 237–243.

50 Puglia E, Fry PD. Aortoenteric fistulas: a preventable problem? *Can J Surg* 1980; **23**: 74–76.
51 Puppala AR, Munaswamy M, Doshi AM, Steinheber FU. Endoscopic diagnosis of aortoduodenal fistula. *Am J Gastroenterol* 1980; **73**: 414–417.
52 O'Mara CS, Williams GM, Ernst CB. Secondary aortoenteric fistula. *Am J Surg* 1981; **142**: 203–209.
53 O'Hara PJ, Hertzer NM, Beven EG, Krajewski LP. Surgical management of infected abdominal aortic grafts: review of a 25-year experience. *J Vasc Surg* 1986; **3**: 725–731.
54 Higgins RSD, Steed DL, Julian TB, Makaroun MS, Peitzman AB, Webster MW. The management of aortoenteric and para-prosthetic fistulae. *J Cardiovasc Surg* 1990; **31**: 81–86.
55 Conn JH, Hardy JD, Chavets CM, Fain WR. Infected arterial grafts: experience in 22 cases with emphasis on unusual bacteria and technics. *Ann Surg* 1970; **171**: 704–714.
56 Bouhoutsos J, Chavatzas D, Martin P, Morris T. Infected synthetic arterial grafts. *Br J Surg* 1974; **61**: 108–111.
57 Christenson J, Eklof B. Synthetic arterial grafts. *Scand J Thor Cardiovasc Surg* 1977; **11**: 43–50.
58 Liekweg WG, Greenfield LJ. Vascular prosthetic infections: collected experience and results of treatment. *Surgery* 1977; **81**: 335–342.
59 Crawford ES, Manning LG, Kelly TF. "Redo" surgery after operations for aneurysm and occlusion of the abdominal aorta. *Surgery* 1977; **81**: 41–52.
60 Yashar JJ, Waiman AK, Burnard RJ, Yashar J. Survival and limb salvage in patients with infected arterial prostheses. *Am J Surg* 1978; **135**: 499–504.
61 Edwards MJ, Richardson JD, Klamer TW. Management of aortic prosthetic infections. *Am J Surg* 1988; **155**: 327–330.
62 Bandyk DF, Kinney EV, Riefsnyder TI, Kelly H, Towne JB. Treatment of bacteria-biofilm graft infection by in-situ replacement in normal and immune-deficient states. *J Vasc Surg* 1993; **18**: 398–406.
63 Wakefield TW. Antibiotic therapy alone for graft infection. In: Bunt TJ, ed. *Vascular Graft Infections*. Armonk, NY: Futura Publishing Comp. Inc., 1994: 205–210.
64 Hollier LH. Conclusive remarks. International Symposium on Management of Aortofemoral Graft Infection. Rome, December, 15–16, 1995.