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Prosthetic Vascular Infection Complicated or not by Aortoenteric Fistula: Comparison of Treatment with and without Cryopreserved Allograft (homograft)

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Objectives: *in patients with vascular prosthesis infection, to compare surgical outcome and long-term results of cryopreserved allograft implantations to conventional surgery.*
Design: *retrospective study.*
Material and Methods: *two asynchronous series of 44 [series I: 1980–1994; 8 patients with aortoenteric fistula (AEF)] and 22 (series II: 1994–1997; 4 patients with AEF) patients were treated for prosthesis infection. All patients had prosthesis excision. In series I, there were 4* in situ *reparations, 26 extra-anatomic bypass, 13 excision only, and one death at laparotomy. In series II,* in situ *cryopreserved allografts were implanted in all patients.*
Results: *operative mortality was 16% in series I and 13.6% in series II. For AEF patients, mortality was 37% in series I and 50% in series II. Among hospital survivors, infection-related late mortality was 13.5% in series I and 5% in series II. For AEF patients, late mortality was 20% in series I and 50% in series II. Incidence of reoperations was 54% in series I and 10.5% in series II* ($p < 0.01$). *Hospital stay was 47.2 $\pm$ 26.4 days in series I and 16.6 $\pm$ 11.5 days in series II* ($p < 0.001$).
Conclusions: *compared to conventional treatment, incidence of reoperations and length of hospital stay are significantly decreased after cryopreserved allograft implantation. However, closure of aortic stump and extra-anatomic bypass gives better results for patients with AEF.*

Key Words: Arterial infection; Vascular prosthesis infection; Arterial homograft; Aortoenteric fistula.

Introduction

Regardless of its location (i.e. articular, vascular), any infected prosthesis must be removed, because such a foreign body serves as a sanctuary for infectious pathogens, in which they are protected from anti-infectious pharmacological agents, and from humoral and cellular defence mechanisms. In the case of vascular prosthetic infection, excision of the infected prosthesis is often impossible without an additional surgical manoeuvre aimed at preserving the arterial blood flow to the limb previously perfused by the prosthesis. The conventional surgical approach to prosthetic vascular infection consists in graft excision and in some form of extra-anatomic bypass. For several authors,[1] such conventional surgical treatment remains the golden standard to which any new form of treatment for prosthetic vascular infection must be compared. However, in case of extensive infection, the complexity of the extra-anatomic reconstruction required to restore limb perfusion may compromise its long-term patency. Therefore, *in situ* implantation of materials presumed to be more resistant to infection, such as rifampin-bonded gelatine-sealed textile graft,[2] autologous vein,[3–5] or arterial allografts harvested from fresh cadavers or from organ donors, has been investigated. Historically, these allografts have first been used for aortic root replacement in the case of extensive aortic valve endocarditis.[6] In 1993, Kieffer *et al*.[7] published the first large series of freshly harvested allografts implanted for *in situ* replacement of infected infrarenal aortic prosthetic grafts. Recently, cryopreserved aortic allografts have been used in animals.[8] Also, as an alternative approach to extra-anatomic bypass or to *in situ* allograft implantations, Darling *et al*.[9] recently proposed retroperitoneal in-line aortic bypass with polytetrafluoroethylene grafts. The aim of our study was to assess, in patients suffering from prosthetic vascular infection, complicated or not by aortoenteric fistula (AEF),

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surgical outcome and long-term results, after implantations of cryopreserved allografts, as compared to conventional surgical treatment.

Material and Methods

Population

The study population included all patients who underwent surgery for prosthetic vascular infection between 1980 and 1997. Series I (1980 to June 1994) consisted of patients treated with conventional surgery, while cryopreserved allografts were implanted in all patients of series II (July 1994 to 1997). Results were compared among patients operated in a single institution, in terms of operative mortality and morbidity, length of hospital stay, long-term survival, recurrent infection and subsequent hospitalisation. In addition, all patients in whom an allograft was implanted were seen at the follow-up clinic for clinical examination, dosage of serum C-reactive protein (CRP), white blood cell (WBC) count, computed tomography (CT) scanning and technetium WBC scan. Demographic characteristics of both series are listed in Table 1.

Series I

Among the 44 patients in series I who underwent conventional surgery between 1980 and 1994, 23 had their initial operation in our institution, whereas 21 were referred to us after an operation had been performed elsewhere. At the time of initial treatment for prosthetic vascular infection, the mean age was 65.1 ± 7.9 years, ranging from 47 to 79 years. There were 40 men and 4 women. In 8 patients, the initial presentation of prosthetic infection was an aorto-digestive fistula, with hematemesis (1 patient), rectal bleeding or melena (6 patients), or both (1 patient). In 30 patients, prosthetic infection developed after one surgical procedure, whereas it occurred in 14 patients after several operations, respectively 2 (6 patients), 3 (3 patients), and 4 or more (5 patients) procedures. At initial surgery, an intra-abdominal vascular anastomosis was constructed in 25 patients, including 18 aortobifemoral bypasses, three aorto-aortic grafts, one aortobiiliac bypass, and three iliofemoral bypasses. Surgery remained extra-abdominal in 19 patients, including three axillofemoral bypasses and 16 femoropopliteal bypasses or femoral reconstructions. Among the group of 30 patients with a history of only 1 vascular surgical procedure, infection developed early (within less than 3 months) in 13 patients (43%), and late (after more than 3 months) in 17 (57%). In contrast, there were 10 (71%) early and 4 (29%) late infections among the 14 patients who had two or more vascular operations.

Infection was due to a variety of organisms (Table 2): Gram-positive cocci, including *Staphylococcus epidermidis* (11 patients), *Staphylococcus aureus* (8 patients), *Streptococcus faecalis* (5 patients); Gram-positive bacilli such as *Corynebacterium* (3 patients); several Gram-negative bacteria (28 patients); *Candida albicans* (4 patients). One patient had methicillin-resistant *Staphylococcus aureus* (MRSA) infection. Multiple organisms grew in 19 patients, a single organism in 14, whereas no organisms were cultured in 7 patients. Bacteriological data were missing in 4 records.

Table 1. Patient preoperative characteristics.

Variables	Series I $n=44$ number (%)	Series II $n=22$ number (%)	Comparison p value
Demographics			
Gender (men/women)	40/4	20/2	NS
Mean age (mean ± SD, years)	65.1 ± 7.9	62.4 ± 8.6	NS
Initial surgery			
Performed elsewhere	21 (48)	13 (59)	NS
In our institution	23 (52)	9 (41)	NS
Previous vascular procedure			
Number			
One operation	30 (68)	7 (32)	<0.01
≥ 2 operations	14 (32)	15 (68)	<0.05
Location			
Intra-abdominal	25 (57)	18 (82)	
Aorta	22	12	
Iliac artery	3	6	
Extra-abdominal	19 (43)	4 (18)	
Prosthetic infection			
Early (<3 months)	23 (52)	12 (55)	NS
One operation	13	1	
≥ 2 operations	10	11	
Delayed (>3 months)	21 (48)	10 (45)	
One operation	17	6	
≥ 2 operations	4	4	

Table 2. Bacteriological data.

Organisms	Series I $n=40$* number (%)	Series II $n=22$ number (%)	Comparison p value
Gram-positive bacteria	24 (60)	17 (77)	NS
Staphylococcus epidermidis	11 (28)	2 (9)	NS
Staphylococcus aureus	8 (20)	13 (59)	< 0.002
Streptococcus faecalis	5 (12)	2 (9)	NS
Corynebacterium	3 (7)	0	NS
Gram-negative bacteria**	28 (70)	14 (64)	NS
Candida albicans	4 (10)	3 (14)	NS
Multiple pathogens	19 (48)	8 (36)	NS
Single pathogens	14 (35)	11 (50)	NS
No pathogen cultured	7 (17)	3 (14)	NS

*Bacteriological data were missing in 4 patients
**Gram-negative bacteria included enterococcus, *Serratia marcescens*, *Enterobacter cloacae*, *Enterococcus faecalis*, *Escherichia coli* etc.

Pathogens that were cultured from patients with AEF included *Enterococcus faecalis* (3 patients) or *cloacae* (2 patients), *Candida albicans* (2 patients), *Serratia marcescens* (1 patient), *Pseudomonas aeruginosa* (1 patient), *Corynebacterium* (1 patient), *Klebsiella pneumoniae* (1 patient). Four organisms grew in 1 patient, 2 in 2 patients, and a single pathogen grew in 4 patients. No organism grew in 1 patient with AEF.

Antibiotics were given in accordance with the sensitivity of the germ. Without this information, vancomycin 1 g/12 h and gentamycin 1 mg/kg/8 h were given intravenously.

Series II

Between 1994 and July 1997, a cryopreserved allograft was implanted *in situ* after excision of the infected prosthesis in 22 patients. Among those, 4 patients had developed an aortoenteric fistula. As shown in Table 1, 9 patients had surgery in our institution, and 13 were referred from other hospitals. There were 20 males and 2 females. The mean age was 62.4 ± 8.6 years, ranging from 48 to 76 years. In 7 patients, prosthetic infection developed after 1 surgical procedure, but after several vascular operations in 15, respectively after 2 (3 patients), 3 (5 patients), and 4 or more (7 patients) procedures. Indication for initial surgery was abdominal aortic aneurysm in 7 patients (4 aortobifemoral bypasses, 1 aortobiiliac bypass, and 2 aorto-aortic grafts), aortoiliac occlusive disease in 11 (5 aortobifemoral bypasses and 6 iliofemoral grafts), and peripheral arteriopathy in 4 (3 femoropopliteal bypasses and one femorofemoral graft). In total, proximal prosthetic anastomoses were intra-abdominal in 18 patients (12 aortic and 6 iliac), and extra-abdominal in 4. Among the group of 7 patients with a history of only 1 vascular surgical procedure, infection developed early in 1 patient (14%), and late in 6 (86%). In contrast, there were 11 (73%) early and 4 (27%) late infections among the 15 patients who had 2 or more vascular operations (Table 1).

Infection was due to multiple microorganisms in 8 patients, to a single pathogen in 11, whereas no pathogens were cultured in 3 patients. Gram-positive cocci grew in 17 patients (*Staphylococcus aureus* in 13, *Staphylococcus epidermidis* in 2, and *Streptococcus pyogenes* in 2), Gram-negative bacilli in 14, and *Candida albicans* in 3 (Table 2). Ten patients had MRSA infection.

Among the 4 patients with AEF, pathogens included *Candida albicans* (3 patients), MRSA (3 patients), *Escherichia coli* (2 patients), *Acinetobacter* (1 patient), *Enterobacter cloacae* (1 patient), and *Morganella morganii* (1 patient). Four pathogens grew in 1 patient, 3 in 1 patient, and 2 in 2 patients.

As in series I, antibiotics were given in accordance with the sensitivity of the germ. Without this information, vancomycin 1 g/12 h and gentamycin 1 mg/kg/8 h were given intravenously. In addition, rifampicine 300 mg/12 h was given orally. This was the only difference in antibiotics policy between the two groups.

Procurement and preservation of allografts

All arterial allografts were supplied by a European Center*, which collects the arteries harvested from organ donors or from fresh cadavers. Bacteriology and virology tests were routinely performed for donors. After harvesting, the grafts were examined by angioscopy in a sterile medium under laminar flow, in order to eliminate arteries with suspect lesions. Decontamination was obtained by a 48 h immersion in a multi-antibiotic solution. Finally, the arteries were frozen in a solution containing a 10% concentration cryoprotective agent – dimethylsulfoxide – and stored at -150 or -180°C in the vapour phase of a liquid nitrogen freezer. The freezing rate was controlled in order to prevent the development of intracellular ice crystals, the freezing process lasting less than 30 min. After the implanting surgeon had ordered the appropriate graft, it was supplied in a liquid nitrogen tanker. Unlike the freezing process, thawing was always rapid. The allograft was thawed in a water bath at 42 °C and then rinsed in successive baths of saline solution containing decreasing concentrations of dimethylsulfoxide. Care was always taken not to handle the frozen allograft clumsily, in order to prevent transverse fractures that may cause immediate or delayed problems. Before implantation, an allograft fragment was collected for subsequent bacteriological culture.[10]

Statistical analysis

Results are expressed as mean $\pm$ SD for quantitative variables and as counts and proportions for categorical findings. Mean values observed in the two series before the operation were compared by means of the classical Student *t*-test and proportions by the chi-squared test. To compare the two series postoperatively, the odds ratio (OR) and associated 95% confidence interval were calculated for each outcome. Results were considered to be significant at the 5% critical level ($p < 0.05$).

* EHB (European Homograft Bank), Military Hospital, Bruynstraat, 1128, Brussels, Belgium.

Results

Series I

Early results

Surgical treatment of vascular infection included excision of the prosthesis in all 44 cases. In 13 patients, there was no additional procedure. Vascular reconstruction was performed with an aortobifemoral textile graft implanted *in situ* in 2 patients; both of them presented with an aortoenteric fistula and died postoperatively. Two patients had a saphenous vein femoropopliteal bypass. An extra-abdominal textile bypass was constructed in 26 patients, including 12 axillofemoral, 4 axillopopliteal, nine transobturator, and 1 femorofemoral bypasses (Table 3). One patient who had developed an aortoenteric fistula died at laparotomy, without further vascular procedure. In this series, an omentoplasty was performed in 1 patient, as biological coverage after excision of the infected prosthesis.

Operative mortality (Table 4) was 16% (7 patients). Among the group of 36 patients without an aortoenteric fistula, mortality was 11% (4 patients). There were 2 cardiac deaths and 2 deaths secondary to pulmonary complications. In contrast, mortality was 37.5% (3 patients) among the group of 8 patients who presented with an aortoenteric fistula. One patient died at laparotomy, and 2 patients died from recurrent infection after a rifampin-bonded textile graft had been implanted, respectively, on the tenth and twenty-first postoperative days. The remaining 5 patients in whom an extra-abdominal bypass was implanted after closure of the aortic stump survived after surgery and were discharged from hospital.

Table 3. Vascular reconstruction after excision of infected prosthesis.

Procedures*	Series I $n=44$ number	Series II $n=22$ number
In situ repair		
With intra-abdominal textile graft	2	0
With extra-abdominal saphenous vein	2	0
With cryopreserved allograft	0	22
Extra-anatomic bypass	26	0
Axillofemoral	12	0
Axillopopliteal	4	0
Transobturator	9	
Femorofemoral	1	
No vascular reconstruction	13	0
Laparotomy-intraoperative death**	1	0

*Excision of infected prosthesis was performed in all patients.
**Patient included on the "intention to treat" principle.

Late results

Thirty-seven patients were discharged from hospital. Among hospital survivors, 9 deaths occurred during the 14-year period. Infection-related late mortality was 12.5% (4 patients) among the 32 patients without fistula and was 20% (1 patient) among the 5 patients with aortoenteric fistula: this patient died 4 years after aortic stump closure and extra-anatomic bypass, from recurrent infection and aortoenteric fistula. In addition, there were 4 non-infection-related late deaths: 2 patients died from cerebrovascular accidents, one from myocardial infarction, and one from unknown origin (Table 4).

At least one additional surgical procedure was performed in 20 patients (54%), either after extra-anatomic vascular reconstruction (19 patients), or after prosthesis excision (1 patient) (Table 5). Indications for additional surgical interventions included mid-thigh amputation in 4 patients (bilateral amputation in one) and recurrent vascular infection in 8. One patient has intractable ischaemic contracture secondary to compartmental syndrome. Among the 4 patients who required thigh amputation, 3 had a revascularisation procedure that later failed, and 1 was in the resection-only subgroup. Excluding deaths during initial hospitalisation, mean cumulative hospital stay was 47.2 ± 26.4 days, ranging from 15 to 130 days.

Series II

Early results

In this series, all 22 patients had a cryopreserved allograft implanted to treat prosthetic infection. Proximal

Table 4. Operative and late mortality.

	Series I $n=44$ number (%)	Series II $n=22$ number (%)	Odds ratio (95% CI)
Operative mortality	7 (16)	3 (14)	1.20 (0.28–5.20)
Patients with AEF	3	2	
Patients without AEF	4	1	
Late mortality*	9 (24)	2 (10.5)	2.73 (0.52–14)
Infection-related	5 (14)	1 (5)	2.81 (0.30–26)
Patients with AEF	1	1	
Patients without AEF	4	0	
Non infection-related	4 (11)	1 (5)	2.18 (0.61–21)
Cerebrovascular accident	2	0	
Acute myocardial infarction	1	0	
Lung carcinoma	0	1	
Unknown origin	1	0	
Total mortality	16 (32)	5 (23)	

AEF = aortoenteric fistula.
*All late mortality percentages are expressed among hospital survivors.

Table 5. Late morbidity among hospital survivors.

Events	Series I $n=37$ number (%)	Series II $n=19$ number (%)	Odds ratio (95% CI)
Reoperation	20 (54)	2 (10.5)	10 (2–49)
After extraanatomic bypass	19		
Axillofemoral	7		
Axillopopliteal	4		
Transobturator	7		
Femorofemoral	1		
After straightforward excision	1		
Amputation	4 (11)*	1 (5)	2.18 (0.23–21)
Disabling ischaemic contracture	1 (3)	0	na
Recurrent infection	8 (22)	1 (5)	4.97 (0.57–43)
Hospital stay (mean ± SD, days)	47.2 ± 26.4	16.6 ± 11.5	<0.001

*Bilateral amputation in 1 patient.

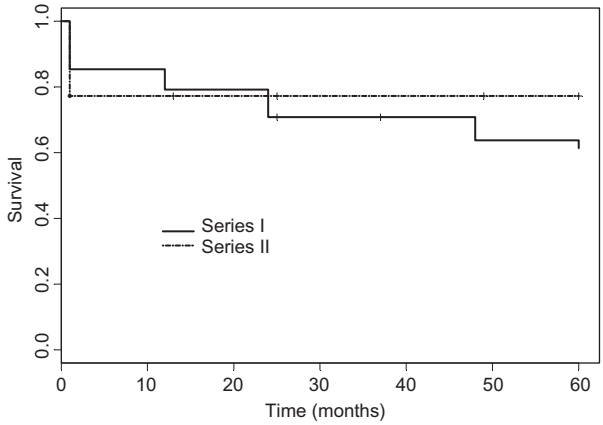

Fig. 1. Five-year survival for all patients, including hospital deaths.

allograft anastomoses were intra-abdominal in 19 patients, whereas 3 patients had femoropopliteal allograft bypasses. Intra-abdominal procedures included 8 iliofemoral, 5 aortofemoral, and 2 aortoiliac bypasses, 2 aorto-aortic grafts, and 2 aortofemoral grafts with additional femoropopliteal bypasses. Whenever technically possible, the allograft was covered by omentoplasty.

Operative mortality (Table 4) was 13.6% (3 patients). Causes of death were massive haemorrhage in 2 patients (after aortobiiliac allograft bypass for aortoenteric fistula), respectively, at postoperative days 9 and 22, and myocardial infarction in 1 patient at postoperative day 4. Operative mortality was 50% (2 patients) in the subgroup of patients with aortoenteric fistula, but was 5.5% (1 patient) in patients without such a fistula. Two patients developed non-lethal early postoperative complications, including 1 recurrent aortoenteric fistula treated with allograft resection, closure of aortic stump, and axillofemoral bypass, and 1 lower extremity ischaemia requiring extension of the femoral anastomosis.

Late results

Nineteen patients were discharged from hospital. Infection-related late mortality was 5%: 1 patient with an allograft implanted for aortoenteric fistula died 8 months after surgery, secondary to rupture of the proximal anastomosis (Table 4). It should be emphasised that all 4 patients who presented with an aortoenteric fistula later developed a rupture of the allograft proximal anastomosis. Three of them died, either in the early postoperative period or during follow-up, and the fourth patient only survives after extra-anatomic bypass grafting. There was 1 non-infection-related late death, from lung carcinoma.

Long-term survival was compared between the 2 groups, with the comparison limited to the first 5 postoperative years as it was the longest follow-up available for patients in series II, and was similar (Fig. 1).

Infection-related late morbidity included 1 midthigh amputation, because of late thrombosis of the femoropopliteal bypass and severe distal arteriopathy, and 1 pseudo-aneurysmal anastomotic leakage treated with a second allograft implantation. Incidence of reoperation was 14% (3 patients). Mean cumulative hospital stay for all surgical procedures was 16.6 ± 11.5 days, ranging from 10 to 61 days (Table 5).

Among the 19 hospital survivors, 16 patients were seen at the follow-up clinic. Mean follow-up was 18 months (extremes: 12–60 months) after allograft implantation. Follow-up included clinical examination, serum CRP dosage, WBC count, CT scanning, and technetium WBC scan. No patient had leucocytosis. Three patients had moderately elevated CRP values, respectively 29, 26 and 20 mg/L (normal values: 0–6 mg/L). No abnormal allograft fixation was observed at technetium WBC scan. At CT scanning, an inguinal collection was detected in 2 patients, without clinical sign of infection or pseudoaneurysmal degeneration. All explanted cryopreserved allografts were submitted to careful histological analysis, and no cracking or other injuries were observed.

Discussion

Although the patients treated most recently undoubtedly benefited from better intensive care and more effective antibiotics than those available in the early 1980s, the operative techniques performed by the same surgical team for both series remained

unchanged. For some authors,[11] however, comparison between 2 different treatments should be limited to the results obtained during the decade immediately preceding change in surgical technique. One major change over the years, however, has been the availability of CT scans and labelled leucocyte scans. In our experience, this significant improvement in diagnostic imaging contributed to earlier diagnosis, at least for the patients treated and followed in our institution. Therefore, our results must be interpreted bearing in mind the specific features of each series.

Both series are comparable in terms of age, sex and proportion of aortoenteric fistula. There are more patients referred from other hospitals in series II (59%) than in series I (48%), but the difference is not statistically significant. The proportions of early and delayed infections are also similar in both series. On the other hand, incidence of infection after 1 surgical procedure is higher in series I (68%) than in series II (32%) ($p < 0.01$), and more patients had an intra-abdominal anastomosis in series II (82%) than in series I (57%) ($p < 0.05$). The significantly higher proportion of extra-abdominal anastomoses (43%) in series I explains why in some patients no vascular reconstruction was performed after excision of the infected material. The significantly higher incidence ($p < 0.002$) of *S. aureus* that we observed in series II (the most recent), as compared with series I, is in opposition with most literature reports: *S. aureus* was responsible for most prosthetic infections 20 years ago, but has now been replaced by *S. epidermidis*.[12]

It should be emphasised that the historical bias which affects the comparison of these 2 series has certainly not been in favour of series II, characterised by a higher incidence of more aggressive pathogens, including MRSA (Table 2) and of intra-abdominal prosthesis. Whereas infection of inguinal prosthesis can usually be treated by simple excision, prosthetic intra-abdominal infections represent a much more difficult surgical challenge. By definition, all patients in series II underwent excision of the infected prosthesis and *in situ* allograft implantation, whereas different surgical therapies were used for patients in series I. For example, patients with extra-abdominal prosthesis underwent simple prosthetic excision, without further vascular reconstruction.

Results of any form of treatment for prosthetic vascular infection can never be considered as definitive. For example, one of our patients initially presenting with an aortoenteric fistula and successfully treated with prosthesis excision and axillobifemoral bypass developed, 4 years after apparent cure, recurrent aortoenteric fistula and died after emergent surgery. At that time, labelled WBC scans were not routinely performed. In contrast, technetium WBC scans were performed several months after cryopreserved allograft implantation in 16 patients and have all been negative. This has now become a routine procedure in our institution.

Operative mortality was 16% for patients treated with conventional surgery, and was 14% after allograft implantations (NS). Total (operative and late) infection-related mortality was 27% for series I, and was 18% for series II (NS). Length of follow-up is obviously different for each series.

For patients who presented with an aortoenteric fistula, operative mortality was 50% after conventional surgical treatment (0% after closure of the aortic stump and extra-anatomic vascular reconstruction), and was 75% after allograft implantation. For these patients treated with prosthesis excision and allograft implantation, technical failure was 100%: 3 patients died and 1 patient developed a rupture of the proximal allograft anastomosis and was finally successfully treated by conventional surgery.

Incidence of reoperation was higher after conventional treatment (45%) than after allograft implantation (10.5%) ($p < 0.01$). Also, reoperations were more frequent after extra-anatomic bypass (73%) than after prosthetic excision without further reconstruction (8%). Total incidence of amputation was 9% after conventional surgery (or 11% among hospital survivors), and was 5% (1 patient) after allograft implantation. In addition, 1 patient in series I is severely impotent because of intractable ischaemic contracture. Among 37 hospital survivors after conventional surgery, infection recurred in 8 patients (22%), and in 1 among 19 patients (5%) that had received an allograft (NS). For hospital survivors, the mean cumulative hospital stay was 47.2 days in series I and 16.6 days in series II ($p < 0.001$). After prosthesis resection and extra-anatomic bypass, other authors reported an operative mortality of 15, 18 and 26%,[11,13,14] respectively, and an incidence of amputation of 5, 9 and 21%,[11,13,14] respectively.

In our series of allograft implantations, there was 1 late amputation and 2 reoperations. One patient who had an aortoenteric fistula was reoperated early for proximal anastomotic rupture; this could be considered as infectious recurrence, despite negative bacteriologic cultures (Table 5). The other reoperation was indicated to correct an anastomotic pseudoaneurysmal degeneration. After allograft implantation, other authors reported an operative mortality of 18–25%,[15,16] which compares favourably with our series, and amputation rates of 2.9–3.5%.[15,16]

Surgical outcome of the 12 patients who presented with an aortoenteric fistula needs to be analysed in

detail. Among 8 patients treated conventionally, 3 died in the early postoperative period and 1 patient died 4 years later of recurrent aortoenteric fistula. This is an operative mortality of 37.5% and a total mortality of 50%. Among 4 patients treated with *in situ* allograft implantation, 2 died postoperatively and 1 patient developed rupture of the proximal anastomosis at postoperative day 8, and was treated with allograft excision, closure of the aortic stump, and axillo-femoral bypass. The only patient discharged from hospital with an allograft implanted for aortoenteric fistula died eight months later, secondary to rupture of the proximal allograft anastomosis. This is a 75% overall mortality and a 100% technical failure. In a larger series of allograft implantation, with an incidence of aortoenteric fistula of 39%, operative mortality was 37%.[16] These results are better than our short experience with allograft implantation in patients with aortoenteric fistula, but substantially worse than our results with prosthesis excision and extra-anatomic vascular reconstruction. It should also be noted that in the experience of Bahnini *et al.*,[16] implanted allografts were freshly harvested, not cryopreserved. In a multicentric study carried out by the users of allografts cryopreserved by the EHB, mortality was 83% for patients with an aortoenteric fistula (65% early and 18% late mortality, respectively).[17] The first reports of early rupture and degeneration of cryopreserved allografts were published by Lehalle *et al.*[18] According to England *et al.*,[19] the incidence of recurrent aortoenteric fistula varies from 25% to 100% after *in situ* reconstructions, and from 17% to 50% after aortic stump closure and extra-anatomic reconstruction.

As an alternative to conventional treatment or to allograft replacement, Nevelsteen *et al.*[4] and Clagett *et al.*[5] have reported their experience with the use of superficial femoro-popliteal veins for aorto-ilio-femoral reconstructions after excision of infected prosthesis. In these series, as in our experience, mortality is influenced by the initial clinical presentation. For example, Nevelsteen *et al.*[4] reported an 11% mortality in patients with isolated prosthetic infection, but a 37.5% mortality in patients with AEF. However, it should be emphasised that, in this series, no patient died because of a rupture of the autogenous vein.

Considering that our poor results after cryopreserved allograft implantation for aortoenteric fistula are also those reported by other surgeons using such allografts from the EHB,[17] the question arises whether the diminished resistance to infection could be due to allograft preparation techniques. Selection and preparation criteria of allografts by the EHB, discussed elsewhere,[10] are extremely selective. However, the pathologist in charge at the EHB insists that clumsy handling during the thawing process could trigger lesions of the extracellular arterial matrix, which could be responsible for later ruptures. Lehalle *et al.*[18] recently reported numerous cases of cryopreserved allograft rupture. These authors[18] questioned the basic principle of cryopreservation, introduced to extend allograft availability and to suppress possible viral contamination from fresh allografts. However, for patients without aortoenteric fistula, cryopreserved allografts are very resistant; rupture of the proximal allograft–aortic anastomosis has not been reported. Several authors[20,21] insist on the importance of complete excision at the infected proximal anastomosis. Was our surgical excision too limited? In each patient, all textile and suture materials were removed, and the extent of excision was only limited by the proximity of the renal arteries.

Since we cannot determine the cause of rupture after allograft implantation for aortoenteric fistula, we have decided not to use allografts for such patients, but to treat them with conventional excision and extra-anatomic reconstruction. Should the femoral sites be infected, thus compromising the distal implantation of a textile axillofemoral bypass, we use an axillofemoral allograft. We also frequently use a composite graft, textile in the upper three quarters, and allograft in the lower quarter, for suture to the infected femoral artery, while sparing allograft length.

Having made these warnings on allograft use in patients with aortoenteric fistula, we must duly acknowledge the feasibility and simplicity of cryopreserved allograft implantation, and the good results observed, at least at early and mid-term follow-up. Cryopreservation allows for the creation of an organ bank, suppresses possible viral contamination, and destroys arterial surface antigenicity.[22] The low incidence of reoperations, compared with conventional surgical techniques, is due to the orthotopic character of arterial repair, which is a decisive factor in maintaining reconstruction long-term permeability. This also explains the lower morbidity, in terms of reoperations or extended hospital stay, as compared to conventional surgical treatment.

Two remarks are important, however, in order to soften our conclusions. First, this series, homogeneous in terms of surgical team, is relatively small, which makes statistical conclusions difficult. In particular, the number of aortoenteric fistula is small in each group and this could impair the validity of our conclusions. Second, the important question of delayed infection recurrence remains. Without a satisfactory answer to this question, no one can pretend to have achieved definitive cure of the infection, whatever the

method employed. However, to date all labelled WBC scans have been negative, which is encouraging.

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