Eur J Vasc Endovasc Surg **27**, 585–589 (2004)
doi: 10.1016/j.ejvs.2004.02.024, available online at http://www.sciencedirect.com on SCIENCE DIRECT®

11-Year Experience with Anatomical and Extra-anatomical Repair of Mycotic Aortic Aneurysms

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Background. *We have reviewed our management, of both ruptured and non-ruptured, abdominal and thoraco-abdominal mycotic aneurysms in order to determine the safety and efficacy of* in situ *and extra-anatomical prosthetic repairs.*
Methods. *Data regarding presenting symptoms, investigations, operative techniques and outcome, were collected on patients treated at a singe centre over 11 years.*
Results. *There were 11 men and four women, with a median age of 70 years (range, 24–79). All but one patient were symptomatic and six had a contained leak on admission. In six patients no organisms were identified in either blood or tissue cultures. Pre-operative CT identified; four infra-renal, four juxta-renal, three (Crawford thoraco-abdominal) type IV, three type III and one type II, aortic aneurysms. Thirteen were repaired with* in situ *prostheses and two required axillo-femoral prosthetic grafts. There were four early deaths. All surviving patients have been followed-up for a median duration of 38 months (range 1/2–112 months). There were two late deaths at 3 months (juxta-renal) and at 2 years (type III), the latter relating to graft infection.*
Conclusions. *In the absence of uncontrolled sepsis, repair of mycotic aortic aneurysms using prosthetic grafts can achieve durable results.*

Key Words: Mycotic; Aortic aneurysm; Infection.

Introduction

Mycotic aortic aneurysms present a surgical challenge and are associated with a high morbidity and mortality. They constitute an uncommon heterogeneous pathologic entity with a reported incidence of 1–3% of all abdominal aortic aneurysms.[1] In 1885 William Osler described a 30-year-old man who died after a period of diarrhoea, chills, headache, cough and fever. Post-mortem examination revealed an aortic valve consumed with vegetations, and in the aortic arch four aneurysms had developed as a consequence of endocarditis. These represented a case of mycotic endarteritis and the largest of these aneurysms had perforated and ruptured into the pericardium. Thus the term mycotic aneurysm was introduced which is somewhat misleading as the majority of aortic infections nowadays are bacterial, thus some authors prefer to use the term 'infected aneurysm'.[2,3]

The predominant micro-organisms associated with mycotic aortic aneurysms are *Staphylococcus* species (30%), *Streptococcus* species (10%) and *Salmonella* species (10%).[4] Fungal infections are rare and usually associated with immunosuppressive states, diabetes mellitus and the use of contaminated needles by drug abusers.[5] In South Africa HIV is now the commonest cause.[6]

In this paper, we have reviewed our management of both ruptured and non-ruptured, abdominal and thoraco-abdominal mycotic aneurysms in order to determine the safety and efficacy of *in situ* and extra-anatomical prosthetic repairs.

Methods

During a 11-year period from 1991 to 2001, 15 patients with primarily infected aortic aneurysms distal to the left subclavian artery were treated at the Regional Vascular Unit, St Mary's Hospital, London, UK. Patients were identified through the prospectively collected Vascular Unit Surgery Registry. Detailed data regarding these patients were gathered in a thorough review of each medical record. Excluded from the

This work has been presented in the best six vascular papers session at the Association of Surgeons of Great Britain and Ireland meeting, University College, Dublin, Ireland, 22–24 May 2002. Abstract published in the *British Journal of Surgery* 2002;**89**(Suppl. 1):72.
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1078–5884/060585 + 05 $35.00/0

study were patients treated for prosthetic graft infections, infections of the ascending aorta and aortic arch, arterial infections secondary to trauma, and patients with positive routine cultures of aneurysm contents. Patients were assessed for age, gender, site of aortic infection, clinical presentation, leukocytosis (white cell count >10,000), fever (temperature >38 °C at presentation), results of blood and intra-operative cultures, complicating conditions related to the aortic infection such as free rupture, aortocaval fistula, aortoenteric fistula, and other sites of arterial infection, operative and long-term survival, and freedom from late prosthetic graft or arterial infection.

Results

Eleven men and four women, with a median age of 70 years (range, 24–79) with primarily infected aortic aneurysms were treated over the study period (Table 1). All but one patient were symptomatic. The one asymptomatic patient had an associated psoas abscess drained the month previously. Nine had back pain, five were pyrexial, six had a raised white cell count, and six were anaemic. Pre-operative CT identified four infra-renal, four juxta-renal, three (Crawford thoraco-abdominal) type IV, three type III and one type II, aortic aneurysms. Of these, six had a contained leak on admission: three infra-renal, one type IV, one type III and one type II aneurysms.

Blood or tissue cultures isolated Salmonella ($n = 3$), Staphylococci ($n = 3$), Streptococci ($n = 1$), coliforms ($n = 1$), *Treponema pallidum* ($n = 1$), while in six patients no organisms were identified (Table 1). All six patients that presented with sterile blood and tissue cultures were already on empirical antibiotic treatment commenced by the referring centre. However, CT scanning was highly suspicious of aortic infection as there was evidence of gas in the aortic wall of a saccular aneurysm. In addition, intra-operative findings for all six patients included purulent peri-aortic collections convincing of aortic infection.

Infra-renal aortic infections were treated with extensive tissue debridement and *in situ* prosthetic graft replacement, unless contamination was thought to be too extensive in which case an extra-anatomical bypass was performed and the aortic stump closed off after excision of the aneurysm. Oral antibiotics were continued for up to 3 months postoperatively. Supra-renal infections were approached through a thoraco-abdominal incision. All patients underwent aortic and periaortic tissue debridement and *in situ* prosthetic graft replacement. Operative survivors were placed on antibiotics for a period of 3 months.

Thirteen were repaired with *in situ* prostheses following extensive local debridement. Two patients required axillo-femoral prosthetic grafts one of which was found to have an aorto-duodenal fistula at the time of surgery. There were four early deaths, two (type IV) relating to blood loss, one secondary to myocardial event (type IV) and one secondary to multi-organ failure (juxta-renal). All surviving patients have been followed-up for a median duration of 38 months (range 1/2–112 months). There were two late deaths at 3 months (juxta-renal) and at 2 years (type III), the latter relating to graft infection.

Discussion

In comparison to non-infected aortic aneurysms, mycotic aneurysms are more likely to be symptomatic. The majority present with pyrexia, a raised white cell count, and up to 50% may have positive blood

Table 1. Patients with mycotic aneurysms and outcomes

	Sex	Age	Symptomatic	Leaking	Culture	Type	Repair	Death
1	M	79	Yes	Yes	−ve	IV	*In situ*	Early
2	F	75	No	No	−ve	JR	Ax-fem	Early
3	M	59	Yes	No	−ve	JR	Ax-fem	Late
4	M	79	Yes	Yes	*Salmonella*	IR	*In situ*	No
5	M	58	Yes	No	−ve	JR	*In situ*	No
6	M	71	Yes	No	*Salmonella*	JR	*In situ*	No
7	F	70	Yes	Yes	Coliforms	III	*In situ*	No
8	M	65	Yes	No	−ve	III	*In situ*	Late
9	F	71	Yes	No	*Salmonella*	IR	*In situ*	No
10	M	74	Yes	Yes	−ve	IR	*In situ*	No
11	M	59	Yes	No	*T. pallidum*	III	*In situ*	No
12	F	24	Yes	Yes	Staph.	II	*In situ*	No
13	M	63	Yes	No	Strep.	IV	*In situ*	Early
14	M	78	Yes	No	Staph.	IV	*In situ*	Early
15	M	60	Yes	Yes	Staph.	IR	*In situ*	No

JR, Juxta-renal; IR, Infra-renal; Ax-fem, Axillo-femoral.

cultures.[3] Radiographic studies are of great value in the diagnosis and planning of the operation. CT imaging may reveal rapid expansion of a known aneurysm or a newly developed aneurysm, gas in the aortic wall, extravasation of contrast in the periaortic tissues, a saccular aneurysm, or a soft tissue mass surrounding the aorta often accompanied by calcified atherosclerotic plaque[7,8] (Fig. 1). MRI can be of similar use to CT scan, although not used in our series.[9] Aortography may reveal a saccular, eccentric, or multilobulated appearance in an otherwise normal aorta (Fig. 2).

Controversy exists about the best operative option for infra-renal mycotic aortic aneurysms. Some authors advocate proximal and distal arterial ligation, aneurysm resection with thorough debridement of surrounding infected tissues and extra-anatomic bypass in the form of either an axillo-bifemoral or two axillo-unifemoral grafts.[10–14] The risks of this approach include aortic stump rupture and a higher risk of thrombosis of the extra-anatomical bypass graft compared to an inline graft.[15–17] Alternatively, others have published on the use of inline or *in situ* graft placement following thorough debridement of the infected field.[18–21] This can be achieved either by using standard prosthetic Dacron grafts, arterial homografts, or superficial femoral venous grafts. Review of the literature on the use of Dacron grafts for *in situ* prosthetic reconstructions shows rather poor results, with an approximately 25% early mortality and a similar incidence of aortic septic complications and vascular re-interventions.[1,22] Moreover, it has been suggested that some 20% of survivors following *in situ* reconstruction need a subsequent extra-anatomic bypass graft owing to infection of the initial graft.[23] In order to reduce the risk of infection of *in situ* grafts it is recommended that they are soaked in rifampicin.[17,24,25] Also, the intra-operative application of gentamicin releasing carriers has been reported.[26] Neither of these antibiotic treatments are proven.

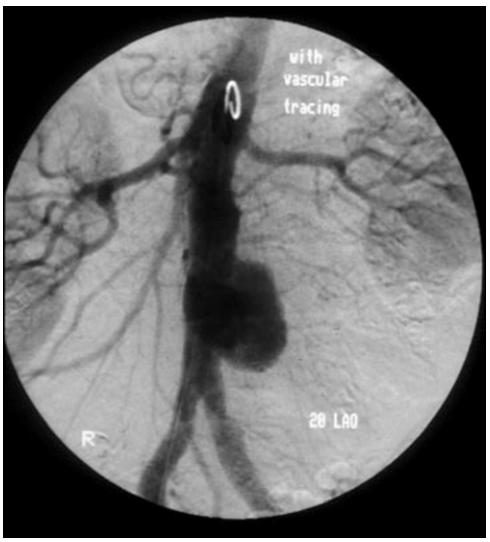

Fig. 1. Angiogram showing a localised saccular aneurysm (blow-out) of the aortic wall, a typical appearance of a mycotic aneurysm.

Some authors have taken a selective approach whereby *in situ* reconstruction was performed in cases of low-grade infection as indicated by a well-circumscribed inflammatory process in the absence of pus. This is typical of salmonella infection and under these circumstances we place an *in situ* Dacron graft. Conversely, if severe purulent infection is seen, we usually perform an extra-anatomical bypass if possible.[3] Fichelle *et al*. in their personal series of 25 infected infra-renal aortic aneurysm operations in which an *in situ* reconstruction of the aorta was used in 21 patients, only three deaths were related to the initial surgery (14%). In addition, none of the surviving patients showed any sign of a late septic recurrence. In the group of four patients who underwent extra-anatomic bypass, two died in the post-operative period and one underwent re-operation 2 years after the initial surgery.[22] Similarly, in our series of four infra-renal and four juxta-renal mycotic aortic aneurysms, six were repaired with *in situ* prostheses following extensive local debridement and two required axillo-femoral prosthetic grafts because of severe purulent infection. There was one early death secondary to multi-organ failure in one of the patients that had an axillo-femoral graft and one late death from unrelated causes.

In recent years there has been a renewed interest in the use of cryopreserved arterial homografts although the risk of aneurismal dilatation remains,[21,27] Both Szilagyi *et al*. and Kieffer *et al*. published favourable results with arterial homografts.[28,29] A number of authors have documented the use the superficial femoral vein (SFV) as an arterial substitute in the repair of both non-leaking and leaking mycotic aortic aneurysms as well as for infected aorto-iliac grafts. The advantage of this conduit over the rest is that it is resistant to infection and is not prone to aneurismal dilatation.[30–32] However, the operative time is invariably longer and there are morbidity issues relating to the leg incisions.

Intensive antibiotic therapy is crucial for successful treatment of infected aortic aneurysms and should be started in the pre-operative period.[24] The optimum duration of antibiotic therapy is still uncertain with recommendations ranging from 6 weeks to lifelong treatment.[24,33,34] Most authors including ourselves

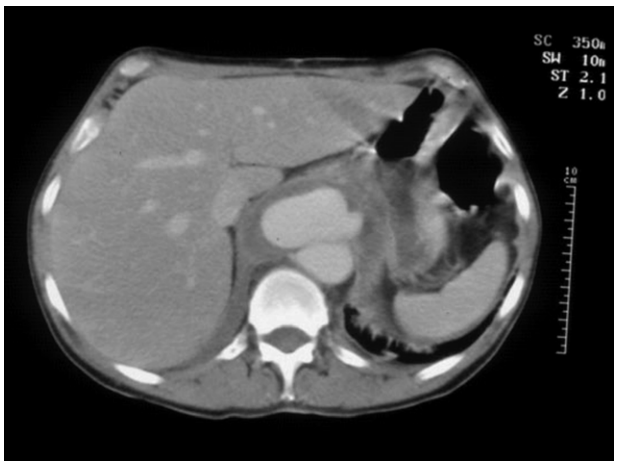

Fig. 2. CT scan showing double lumen appearance of a saccular mycotic aneurysm of the supra-renal aorta.

would recommend a 3–6 month course of post-operative antibiotic therapy at which stage it can be discontinued provided there is no clinical, haemato-logical or radiological evidence of ongoing sepsis.[3]

Infection involving the suprarenal and thoraco-abdominal aorta poses distinct challenges due to the necessity of visceral revascularisation. In each case the visceral grafts must come in proximity to the infected supra-renal aorta. Since 1962 fewer than 50 patients have been reported in the English language literature. In addition, a variety of reconstructive techniques have been used making comparative conclusions difficult.[35] Some have reported resection of a supra-celiac aneurysm with closure of the aortic stump and reconstruction with an axillo-bifemoral graft that perfused the distal aorta and visceral arteries retrogradely.[36] The concern with this extra-anatomical bypass is that flow will be inadequate for viscera and legs, as well as an increased risk of thrombosis.[37] The majority of patients with infected thoraco-abdominal aortic aneurysms have been treated by resection of the visceral aorta, graft inter-position, and reperfusion of the visceral vessels by either 'side-arm' grafts or direct reattachment to the aortic graft.[33,35] In our series of seven mycotic thoraco-abdominal aneurysms all were repaired with inline Dacron grafts. Two of the type IV mycotic thoraco-abdominal aneurysms died within 30 days of surgery. One of the type III repairs re-presented with graft infection after 2 years and died as a result. Although the numbers are small the 20% re-intervention rate amongst survivors is similar to that generally reported in the literature.[1,22,23]

In conclusion, our data of abdominal and thoraco-abdominal mycotic aneurysms indicate that although operative mortality is high, in the absence of severe purulent infection repair using prosthetic grafts can achieve durable results.

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Accepted 26 February 2004