Secondary aortoenteric fistula: Contemporary outcome with use of extraanatomic bypass and infected graft excision

Laurie M. Kuestner, MD, Linda M. Reilly, MD, Douglas L. Jicha, MD, William K. Ehrenfeld, MD, Jerry Goldstone, MD, and Ronald J. Stoney, MD, *San Francisco, Calif.*

Purpose: The standard treatment for secondary aortoenteric fistula (SAEF) has been infected graft removal (IGR) and extraanatomic bypass (EAB), an approach criticized for its high rate of death, amputation, and disruption of aortic closure. Recently, graft excision and in situ graft replacement has been proposed as a safer treatment alternative. Because the current outcome that can be achieved by use of the standard treatment of SAEF has really not been established, we reviewed the records of 33 patients treated for SAEF at our institution during a contemporary time interval (1980 to 1992).

Methods: Thirteen patients (39.4%) were admitted with evidence of gastrointestinal bleeding and infection, whereas nine (27.3%) only had bleeding, 10 (30.3%) only had signs of infection, and one SAEF was entirely occult (graft thrombosis). Four patients required emergency operation. The fistula type was anastomotic in 13 (39.4%) patients, paraprosthetic in 15 (45.5%), and not specified in 4 cases. Thirty-two patients underwent EAB followed immediately by IGR (n = 16, 48.5%) or followed by IGR after a short interval, averaging 3.9 days (n = 16, 48.5%). The final patient underwent IGR, followed by EAB.

Results: Follow-up on 31 patients (93.9%) averaged 4.4 ± 3.7 years. There were nine deaths (27.3%) resulting from the SAEF, six perioperative and three late. Three patients (9.1%) had disrupted aortic closure. There were four amputations in three patients (9.1%), two perioperative and two late. Late EAB infection occurred in five patients (15.2%), leading to one death and one amputation. EAB failure occurred in six patients, two during operation and four late, leading to one amputation. The cumulative cure rate for this SAEF group was 70% at 3 years and thereafter. Compared with our earlier SAEF experience, this is a decline of 21% in the mortality rate, 19% in aortic disruption, and 27% in limb loss.

Conclusions: We conclude that outcome reports based on SAEF series extending over long time intervals do not accurately represent the results that are currently achieved with standard SAEF treatment with use of EAB plus IGR. This improved outcome is attributed to wide debridement of infected tissue beds, reduced intervals of lower body ischemia, and advances in perioperative management. To determine whether any new treatment approach actually offers improved outcome in the management of SAEF, comparison with EAB plus IGR should be limited to patients treated within the last decade at most. (J VASC SURG 1995;21:184-96.)

Secondary aortoenteric fistula (SAEF) remains a devastating complication of aortic prosthetic grafting, with an observed incidence between 0.36% and 1.6%.[1-9] The treatment of SAEF, by use of a variety of operative approaches, has a reported mortality rate between 25% and 90%,[4,6-30] an associated major amputation rate varying from 5% to 25%,[7-15] and an aortic stump disruption rate of 10% to 50%.* The frequency of these adverse outcomes has prompted some to recommend in situ aortic graft replacement as a safer and more successful treatment[33-36] than the more traditional operative management, which con-

From the Division of Vascular Surgery, University of California, San Francisco.

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Reprint requests: Linda M. Reilly, MD, Vascular Surgery, M-488, University of California, San Francisco, CA 94143.

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*References 3, 5-13, 19-29, 31, 32.

Table I. Details of initial aortic graft operation

	No.	*%*
Indication		
Aneurysmal disease	15	45.5
Occlusive disease	17	51.5
Both	1	3.0
Graft location		
Aortic tube	3	9.1
Aortoiliac	13	39.4
Aortofemoral	17	51.5
Proximal anastomosis		
End-to-side	11	33.3
End-to-end	22	66.7

sists of infected graft removal (IGR) and extraanatomic bypass (EAB). However, the outcome data summarized above come from series consisting of small numbers of patients accumulated over long time intervals and usually include a variety of operative techniques. Thus few data clearly establish the contemporary results that can be achieved with the standard treatment of IGR and EAB. To investigate this, we reviewed the outcome of a consecutive series of patients with secondary aortoenteric fistula treated by use of EAB and infected graft excision at the University of California, San Francisco (UCSF) since 1980.

METHODS

Between 1980 and 1992, 47 patients with a diagnosis of SAEF were seen at our institution, including all aortoenteric fistulas and graft-enteric erosions. Fourteen patients did not undergo standard therapy ($n = 9$), were referred to UCSF after treatment had been initiated elsewhere ($n = 4$), or had essentially exsanguinated before operation progressed beyond placement of the aortic cross-clamp ($n = 1$). These patients (of whom eight survived and six died) were excluded from further analysis. The remaining 33 patients, 21 men and 12 women (mean age of 69.5 ± 8.3 years), form the basis of this report. Two patients (6.1%) had their initial aortic graft placed at UCSF; the remaining patients (93.9%) underwent the initial aortic graft operation elsewhere. Data were obtained by review of the hospital charts, office records, and referring physician records. Follow-up was determined by record review, as well as by telephone interview of the patient, the referring physician or the current primary care physician. Cumulative cure rates, graft patency rates, and amputation rates were calculated by use of life-table analysis.

Table II. Presenting symptoms and findings for aortoenteric fistulas

	No.	*%*
Bleeding presentation		
GI bleeding	22	66.7
Only	9	27.3
With infection	13	39.4
None	11	33.3
Pattern		
Acute	16	48.5
Chronic	5	15.2
Occult	2	6.1
Acute and chronic	1	3.0
Recurrent	7	21.2
Hypotension	8	24.2
Infection presentation		
Groin wound changes*	8	24.2
Sinus tract	5	15.2
Fever/chills	20	60.6
Septic emboli	9	27.3
Hypotension	3	9.1
Pyrexia	22	66.7
Leukocytosis	20	60.6
Positive cultures	18	78.3
Blood ($n = 15$)	11	73.3
Wound ($n = 8$)	7	87.5
Miscellaneous presentation		
Weight loss	5	15.2
Malaise	12	36.4
Lower extremity ischemia	6	18.2
Graft occlusion	7	21.2
Pulsatile mass	6	18.2

GI, Gastrointestinal.
*Erythema, swelling, pain, drainage, or bleeding.

CLINICAL MATERIAL

Initial aortic grafting was prompted by aneurysmal and occlusive disease with equal frequency (Table I). About half of the aortic grafts were aortofemoral in location and tube grafts were rare. End-to-end proximal anastomoses were twice as common as end-to-side anastomoses.

Factors that may have contributed to the development of graft infection and fistula formation were present in 22 cases (66.7%). Six patients (18.2%) had emergency aortic reconstruction for ruptured aneurysms, 14 patients (42.4%) had subsequent reoperations on the aortic graft (ranging from one to three procedures), and nine patients (27.3%) had various perioperative complications, including ureteral injury ($n = 2$), duodenal injury ($n = 1$), concomitant gastrointestinal procedure (cholecystectomy, 1; small bowel resection with appendectomy, 1), infection (pneumonia, 1; wound seromas with fever, 1; gram-negative sepsis caused by acalculous cholecystitis, 1) and reoperation for bleeding ($n = 1$).

Most patients were admitted with some evidence of gastrointestinal bleeding ($n = 22$, 69.7%), either

Table III. Methods of diagnostic evaluation

		Abnormal		*Diagnostic*	
	No.	*No.*	*%*	*No.*	*%*
Esophagogastroduodenoscopy	17	9	52.9	2	11.8
Abdominal/pelvic CT	24	22	91.7	8	33.3
Angiography	30	12	40.0	0	
Sinography	3	3	100.0	0	
Colonoscopy	10	6	60.0	0	
Upper GI series	8	5	62.5	1	12.5
Lower GI series	5	2	40.0	0	
Magnetic resonance scan	6	6	100.0	0	
Gallium scan	2	1	50.0	0	
Indium WBC scan	7	4	57.1	0	
Technetium WBC scan	1	0	0.0	0	

GI, Gastrointestinal; *WBC,* white blood cell.

alone (n = 9, 24.2%) or in combination with symptoms and signs of infection (n = 13, 45.5%). However, nine patients (27.3%) showed evidence only of infection, without any bleeding episodes or even guaiac-positive stool. One aortoenteric fistula was entirely occult and presented as graft thrombosis. Most patients who bled were admitted with acute gastrointestinal hemorrhage, and almost one third had recurrent bleeding episodes before diagnosis and definitive therapy (Table II). However, almost all patients stopped bleeding and were stabilized hemodynamically, such that emergency operation was only required four times.

The symptoms and signs of infection were varied (Table II). The most frequently present were elevated temperature (mean T_{max} = 38.2 ± 0.9) and leukocytosis (13.7 ± 5.2 10^9 cells/L). Preoperative cultures of wounds, drainage, or blood were only sporadically obtained, but they were usually positive (18 of 23, 78.3%). Most patients (75%) had no local wound changes to suggest any underlying graft problem. Infection alone rarely produced hypotension (9%), whereas bleeding did more often (24%). Surprisingly, septic embolization occurred in more than one quarter of the patients in this series (Table II). Lower extremity ischemic symptoms were also present in six patients, and seven grafts were partially (one limb) or completely occluded. The six palpable pulsatile masses were equally distributed between the proximal and distal anastomotic sites. Eight patients (24.2%) had an entirely normal physical examination result.

The most common preoperative assessment consisted of esophagogastroduodenoscopy (EGD), computed tomography (CT) of the abdomen and pelvis and angiography (Table III). The result of EGD was abnormal more than half of the time, but it was *diagnostic of SAEF* in only two cases (graft material seen). The false-negative rate was quite high (47.1%). Endoscopy to the fourth portion of the duodenum was only documented in six patients who underwent EGD in this series. The CT scanning result was almost always abnormal, but it was considered to be diagnostic of aortoenteric fistula (air around the graft) in only eight cases. Of the 12 arteriographic studies that showed abnormalities suggesting possible graft infection, four showed proximal suture line (aortic) false aneurysms, six showed distal suture line (femoral or iliac) false aneurysms, one study showed proximal and distal suture line false aneurysms, and one study showed intraluminal graft limb filling defects. Although these findings were consistent with a graft infection, they were only suggestive of SAEF. Consequently, the diagnosis of SAEF was definitively made before operation in only 11 patients (33.3%). It was suspected and confirmed during operation in 17 cases (51.5%), and it was unsuspected until encountered during operation in the remaining five patients (15.2%). A variety of other investigative modalities were used less commonly in this patient group, but were only responsible for one additional confirmed preoperative diagnosis (Table III). For the most part these tests demonstrated findings diagnostic of or strongly suggestive of a graft infection but did not offer definitive evidence for the presence of a fistula.

The mean interval between placement of the original aortic graft and definitive treatment of SAEF by graft excision and EAB was 6.1 ± 4.1 years. For those patients who underwent reoperation on the aortic graft at some point, the mean interval between the most recent operation and the graft removal was 4.3 ± 3.8 years. The typical elapsed time between the onset of symptoms and definitive operative

Table IV. Details of graft infection operation

	No.	*%*
Type		
Emergency	4	12.1
Urgent	29	87.9
Technique		
Sequential	16	48.5
Staged	16	48.5
Traditional	1	3.0
Axillofemoral bypass outflow artery		
Common femoral	14	42.4
Superficial femoral	12	36.4
Deep femoral	5	15.2
Small graft remnant	2	6.1
Cross-femoral conduit		
Prosthetic	13	39.4
Saphenous vein	11	33.3
Ilioiliac anastomosis	5	15.2
Endarterectomized superficial femoral artery	2	6.1
Combination	2	6.1
Infected graft removal		
Complete	28	84.8
Complete (intention to treat)	3	9.1
Partial	2	6.1
Aortic clamp level		
Supraceliac	4	12.1
Suprarenal	10	30.3
Infrarenal	17	51.5
Other	2	6.1
Aortic stump protection		
None	21	63.6
Omentum	3	9.1
Anterior spinal ligament	2	6.1
Unknown	1	3.0
Not applicable	6	18.2

Table V. Details of aortoenteric fistulas

	No.	*%*
Type		
Anastomotic	13	39.4
Paraprosthetic	15	45.5
Both	1	3.0
Unknown	4	12.1
Location		
Duodenum	23	69.7
Jejunum	6	18.2
Both	1	3.0
Ileum	2	6.1
Sigmoid colon	1	3.0

treatment was 84.8 ± 91.8 days. In spite of this diagnostic delay, only four emergency operations (12.1%) were necessary.

Thirty-two patients underwent EAB first, followed by infected graft removal and fistula closure, either under the same anesthesia (sequential technique, $n = 16$, 48.5%) or after a brief interval (staged technique, $n = 16$, 48.5%). The average staging interval was 3.9 ± 2.3 days (range 1 to 8 days, median 4 days). Two patients who were to undergo staged graft removal died before the second stage could be performed, one of aortic false aneurysm rupture and one of the consequences of prolonged lower body ischemia. The final patient underwent aortic graft removal and fistula closure first, followed immediately by EAB (traditional technique).

Infected graft removal was complete in 28 patients (84.8%). Two of the remaining five patients are described above and are included in the complete excision group on the basis of intention to treat. In one additional patient a small remnant of graft was inadvertently left in the right groin and is also considered to be in the complete excision group. The two remaining patients (6.1%) each had small cuffs of the old graft intentionally left in place at the femoral anastomotic sites. Infected graft removal occasionally required supraceliac ($n = 4$) or suprarenal ($n = 10$) aortic clamping but was performed with infrarenal aortic clamping in the remainder of the cases (Table IV). Methods to protect the aortic stump were rarely used, but aggressive excision and debridement of the retroperitoneum and the aorta were always performed, and a tension-free, two-layer aortic closure with monofilament suture was standard. The retroperitoneum is not routinely drained, but drains are more likely to be placed if there is a large, defined abscess cavity.

The extraanatomic revascularization consisted of an axillofemoral bypass to either the ipsilateral common femoral, superficial femoral, or deep femoral artery (Table IV). The large number of intraabdominal grafts in this series allowed many of the distal anastomoses of the axillofemoral graft to be performed to the common femoral artery, because there was no prosthetic material in the groins in 49% of the cases. Similarly this allowed the femorofemoral conduit to be prosthetic ($n = 13$) or to be fashioned by end-to-end anastomosis of the common iliac arteries ($n = 5$) in more than half of the cases (Table IV).

The aortoenteric fistulas were equally divided between anastomotic and paraprosthetic (Table V). Almost all fistulas were located in either the duodenum or proximal jejunum (87.9%), but they occasionally involved the colon or distal small bowel.

Preoperative wound or wound drainage cultures were almost always positive for multiple organisms

Table VI. Culture results

		Single organism		*Multiple organisms*		*S. Epidermidis*		*Only S. epidermidis*	
	No.	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*
Preoperative									
Wound/drainage	8	0	–	7	87.5	1	12.5	0	–
Blood	15	4	26.7	6	40.0	0	–	0	–
Intraoperative									
Graft	21	6	28.6	8	38.1	0	–	0	–
Perigraft tissue	30	8	26.7	14	46.7	3	10.0	1	3.3
Artery	9	4	44.4	2	22.2	0	–	0	–
Miscellaneous sites*	7	2	28.6	3	42.9	0	–	0	–

*Buttock/foot/knee abscesses; thrombus; retroperitoneum.

Table VII. Outcome of treatment for aortoenteric fistulas

	Perioperative		*Late*		*Total*	
	No.	*%*	*No.*	*%*	*No.*	*%*
Death	6	18.2	3	9.1	9	27.2
Amputation	2	6.1	1	3.0	3	9.1
Aortic stump disruption	2	6.1	1	3.0	3	9.1
EAB occlusion	2	6.1	4	12.1	6	18.2
EAB infection	0	–	5	15.2	5	15.2

(Table VI), as were preoperative blood cultures. Intraoperative graft and perigraft tissue cultures usually grew multiple organisms, whereas intraoperative artery cultures were more likely to grow a single organism. Overall single-organism isolates were somewhat less common than multiple isolates (26.7% vs 44.4%). *Staphylococcus epidermidis* was isolated from four cases. In one case it was the solitary organism recovered from the graft/perigraft tissue, but *Pseudomonas* was also cultured from the aortic wall. However, no special techniques were used to increase the recovery rate for *S. epidermidis*. There were only four entirely culture-negative infections among this patient group.

RESULTS

Mortality. There were six perioperative (< 30 days) deaths (18.2%). Two patients who were expected to have staged treatment of their aortic graft infection died between the first- and second-stage operations. In one case the proximal aortic false aneurysm ruptured 2 days after EAB, and the patient could not be saved by emergency operation. The second patient was admitted with extensive pelvic and lower body ischemia caused by thrombosis of her aortofemoral graft. Even after EAB these changes were irreversible, and thus the second-stage procedure was never performed. One patient had a respiratory arrest of unknown cause, and autopsy was not performed. One patient died of sepsis of undetermined cause, but it was presumed to represent persistent retroperitoneal infection. One patient died of metastatic pancreatic carcinoma, which was found incidentally at the time of infected graft removal. In the final patient her aortic closure ruptured 10 days after IGR, and autopsy revealed fungal aortitis. Of note this patient did not have an interrupted and oversewn aorta (aortic stump) but had primary closure of the longitudinal aortic defect created by removing the end-to-side aortic graft.

There were three late deaths related to the aortic graft infection (9.1%). Two patients died of aortic stump disruption, one at 2.3 months and one at 5.1 months after operation. Of note, in the latter patient the aortic stump first disrupted perioperatively, and he survived emergency repair. In total there were four instances of aortic stump disruption in three patients (9.1%), ultimately causing death in all three of the patients. The final death occurred in a patient who underwent redo in-line aortic reconstruction because of infection involving the prosthetic axillofemoral graft. Unfortunately she had development of a second aortoenteric fistula (not to the duodenum, as in her original fistula, but to the sigmoid colon), and she ultimately died as a result of that complication.

The crude overall mortality rate for this series is 27.2% (Table VII). During follow-up, which averaged 4.4 ± 3.7 years, life-table analysis shows the

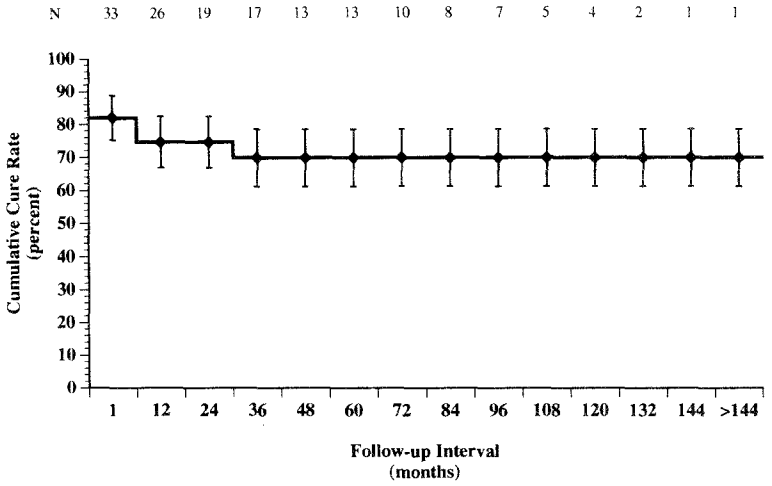

Fig. 1. Life-table shows cumulative rate of cure for aortoenteric fistula and graft infection managed by EAB followed by IGR and fistula closure. Maximum SE = 8.7%.

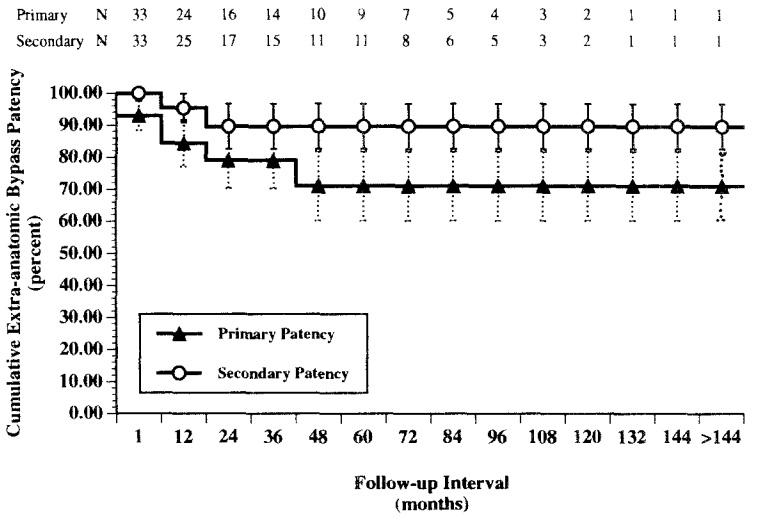

Fig. 2. Life-table shows cumulative primary and secondary patency rates of extraanatomic revascularizations used in this series of patients. Maximum SE = 10.8% for primary patency and 7.0% for secondary patency.

cumulative cure rate for the treatment of the aortoenteric fistula and graft infection was 74.5% at 1 year, reached 70% at 3 years, and remained constant thereafter (Fig. 1).

Extraanatomic bypass failure. There were six failures of the extraanatomic bypass, two perioperatively and four during follow-up, for a crude incidence of 18.2% (Table VII). One patient with a perioperative EAB thrombosis had a successful thrombectomy but required one above-the-knee amputation and was then lost to follow-up. Three failed grafts underwent successful thrombectomy with or without graft revision and thereafter remained patent throughout follow-up. Two grafts remained chronically occluded and necessitated replacement with a contralateral EAB. Altogether the six patients required 13 operations to correct these failures of the EAB. The primary and secondary patency rates for these extraanatomic reconstructions are summarized in Fig. 2. By life-table analysis the 1-year primary patency rate was 84.3%, whereas the secondary patency rate was 95.4%. At 4 years the primary patency rate was 71.0%, and the secondary patency rate was 89.6%. Thereafter there were no further graft failures.

Limb salvage. Three patients required four

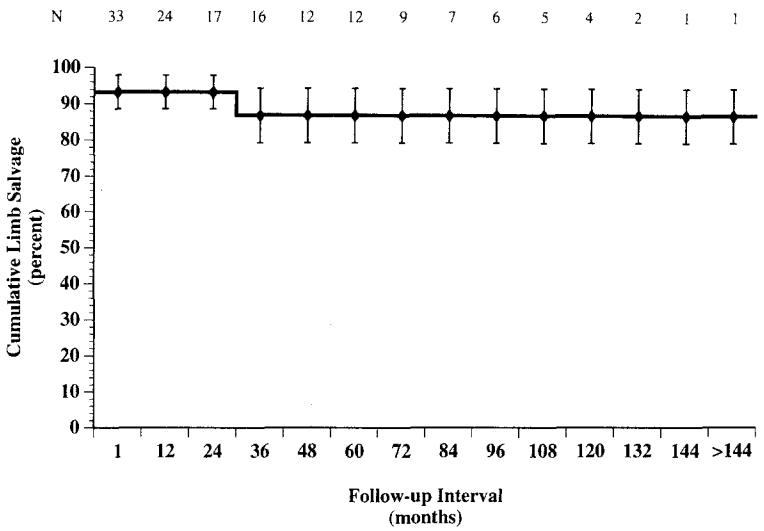

Fig. 3. Life-table summarizes cumulative limb salvage during follow-up. Maximum SE = 7.6%.

major limb amputations (two above-knee, two below-knee), a crude incidence of 9.1%. Two amputations resulted from the treatment of infected EABs. One resulted from EAB thrombosis. The cumulative limb salvage is summarized in Fig. 3.

EAB infection. Five patients had development of infection of the prosthetic axillofemoral bypass during follow-up. Three were successfully treated by placement of a new contralateral axillofemoral graft and excision of the infected conduit. Two EAB infections resulted in amputation and death in one patient, and amputation alone in the other patient. Altogether the five patients underwent 10 operations for treatment of the EAB infection.

DISCUSSION

The controversy over the optimal method of treatment for secondary aortoenteric fistula has been fueled by continued publication of series showing high mortality, amputation, and aortic stump disruption rates. In 1983 Bunt[29] summarized the reported experience in the management of SAEF. Excluding patients whose operative management consisted of laparotomy only, the overall mortality rate was 58.4%. For the most part, this represented the perioperative mortality rate because the series did not contain information regarding late mortality rates. Furthermore, data regarding the incidence of amputation or disruption of the aortic stump were not included in that review. Three years earlier, Kiernan et al. had reported a less exhaustive review of published cases and noted a similar mortality rate of 52.8%, with a perioperative rate of 46.5% and a late death rate of 6.3%. His report also contained no data regarding the frequency of amputation but did note aortic stump disruption in 10.3% of cases. In the series published since Bunt's review[29] (or not included in his review), which include data specific to the outcome of treatment of aortoenteric fistulas,[4,6-28,30,33-36] the overall mortality rate remains 57.0%. Only one third of these series[7-15] include amputation data, which occurred on average in 8.8% of cases. However, most of the studies did report aortic stump disruption rates, which averaged 21.6%.†

In analyzing these outcomes, it is evident that the data generally are based on small-volume studies, which accumulated patients over very long time intervals. In spite of the fact that several series have reported improved results in more recently treated patients with SAEF[6,15,25] or aortic graft infection in general,[3,30] the effect of including all patients treated over long time intervals has not really been considered when comparison is made between operative approaches. Furthermore in these reports a variety of operative techniques are used, including local repair, graft excision without revascularization, graft excision with in situ replacement, and graft excision with EAB. Thus pooling this data cannot provide clear information regarding the current outcome, which can be achieved with one consistent treatment approach.

The results reported in our contemporary series of patients with SAEF represent a 21% reduction in mortality rate, a 27% reduction in limb loss, and a

†References 3, 5-13, 19-29, 31, 32.

Table VIII. Results of graft removal and extraanatomic bypass for aortoenteric fistula

Study	*Study dates*	*Study interval (yr)*	*No.*	*Mortality*			*Follow-up period*	*Stump disruption*
				Perioperative	*Late*	*Total*		
Selected series								
Kiernan et al.[23]	1964-1978	14	6	3 (50.0%)	1 (16.7%)	4 (66.7%)	NS	2 (33.3%)
Shah et al.[28]	NS	2	3	1 (33.3%)	1 (33.3%)	2 (66.7%)	2.0	0
Flye et al.[20]	1970-1982	12	10	NS	NS	7 (70.0%)	NS	0
Gozzetti et al.[22]	1960-1982	22	1	0	0	0	2.0	0
Trout et al.[13]	NS	NS	4	1 (25.0%)	0	1 (25.0%)	3.5	0
Yeager et al.[15]	1975-1984	9	7	3 (42.9%)	0	3 (42.9%)	1.3	0
Thomas et al.[34]	NS	4	1	1 (100%)	0	1 (100%)	0.1	0
Salo et al.[18]	1974-1984	10	9	4 (44.4%)	1 (11.1%)	5 (55.6%)	NS	NS
Moulton et al.[24]	1978-1985	7	13	4 (30.8%)	3 (23.1%)	7 (53.9%)	NS	5 (38.5%)
Vollmar et al.[35]	1974-1984	10	6	NS	NS	5 (83.3%)	NS	NS
Umpleby et al.[14]	1980-1984	4	7	1 (14.3%)	2 (28.6%)	3 (42.9%)	0.6	1 (14.3%)
Tilanus et al.[19]	1978-1985	7	10	7 (70.0%)	NS	7 (70.0%)	NS	3 (30.0%)
Aarnio et al.[10]	1985-1988	3	3	0	1 (33.3%)	1 (33.3%)	1.0	0
Higgins et al.[8]	1977-1987	10	7	2 (28.6%)	2 (28.6%)	4 (57.1%)	0.5	1 (14.3%)
Jacobs et al.[16]	1972-1989	17	2	0	0	0	4.5	0
Bergeron et al.[6]	1970-1989	19	17	4 (23.5%)	3 (17.6%)	7 (41.2%)	4.0	5 (29.4%)
Bacourt[41]	1979-1989	10	40	12 (30.0%)	NS	12 (30.0%)	NS	6 (15.0%)
Peck et al.[9]	1980-1991	11	21	NS	NS	11 (52.4%)	NS	3 (12.0%)
Average		10.1	9.3	43 (33.1%)	14 (17.5%)	80 (47.9%)		26 (17.1%)
Literature review	(25 series)							
Bunt[29]	1952-1982	30	93	NS	NS	34 (36.4%)	NS	NS

NS, Not clearly stated.

19% reduction in the rate of aortic stump disruption when compared with the results we obtained among patients treated during the preceding 15 years.[37] We believe the improved survival rate may result from a number factors. First, of course, is the dramatic and ongoing improvement in preoperative preparation, intraoperative anesthetic management, and postoperative care that has occurred in the past quarter century. Second, the importance of thorough debridement of the infected retroperitoneum and perigraft tissue and of the infected artery (aorta) in the successful management of these patients has gradually become apparent. At the time of infected graft removal we routinely debride all necrotic and obviously infected retroperitoneal tissue, while preserving necessary vital structures. This debridement includes any false aneurysm wall, abscess cavity, perigraft capsule (including that extending along the graft limbs), the necrotic margins of the bowel wall at the fistula site, and, finally, the involved aorta itself. It is mandatory to close the aorta at a level where it appears healthy and not involved by infection. Attempts to close obviously infected aorta will fail, and this will probably be fatal. Frequent use of suprarenal or supravisceral aortic cross-clamping will allow more proximal aortic debridement. It is almost always possible to close the aorta below the renal arteries and still be above the level of aortic wall involvement. However, if the aorta is involved at the renal artery level, then renal revascularization with the splenorenal or hepatorenal technique is necessary. In this series no patient required renal artery relocation to allow more proximal closure of the aortic stump.

Finally, routine performance of the extraanatomic revascularization *before* the transabdominal removal of the infected graft has allowed us to avoid lower body ischemia with all of its adverse metabolic consequences.[38] This last factor may help to explain why our survival rate with EAB and IGR is better than the survival rates recently reported in the literature (Table VIII). Of the 18 series summarized in Table VIII, 12 used the traditional operation sequence (IGR *followed by* extraanatomic revascularization) in all or most of their patients.‡ Peck et al.[9] did report a 25% mortality rate in patients treated by EAB followed by IGR, in comparison to a 64% mortality rate for those who underwent the traditional sequence of operations. Those authors were quick to point out that this difference in survival results, at least in part, from the greater frequency of hemodynamic instability among patients in whom graft removal was required first because of bleeding. However, not all patients undergoing the traditional sequence of operations in their or other series were actually hemodynamically unstable.

‡References 9, 10, 14-16, 18, 19, 22, 24, 28, 34, 35.

Obviously not all patients are candidates for EAB first followed by IGR. Because the course of bleeding associated with an aortoenteric fistula is unpredictable, the treatment technique chosen for any patient whose presentation has included active bleeding must be carefully individualized. A patient who has active bleeding at the time of initial presentation that has not stopped or stabilized is not a candidate for EAB followed by IGR. A patient who has had active bleeding, with associated hemodynamic instability, but that has stopped and stabilized with appropriate resuscitation, is a candidate for EAB followed by IGR at the same operation, without an interval delay. A patient who has had active bleeding but without any instability is a candidate for EAB followed by IGR with or without an interval delay. However, for this patient any interval delay should be kept very brief, particularly if there is an associated proximal anastomotic false aneurysm. A patient who has only had occult bleeding clearly is a candidate for EAB before IGR, and the staged approach is appropriate. Again if there is an associated aortic false aneurysm, the staging interval should be minimal. The length of the staging interval is entirely empiric and in general should be as short as the patient's condition will allow. Over time we have progressively shortened this interval.

In addition to the bleeding pattern, the decision to perform both parts of the procedure with the patient under the same anesthesia is also influenced by the expected length of each part of the procedure. When the EAB will be short and straightforward (as is the case when the infected aortic graft is a tube graft or an aortoiliac graft, thereby allowing a prosthetic cross-femoral graft to be placed in previously nonoperated groins), we are more likely to complete the procedure at one setting. When the EAB portion of the procedure is expected to be lengthy (as occurs when the infected aortic graft extends into the groins and autogenous repair in previously operated fields is necessary), we are more likely to use the staged approach.

Eliminating extended periods of extensive lower body ischemia also contributes to the lower rate of major limb loss reported in this series. Equally important in preventing limb loss is our routine use of axillofemoral/femorofemoral bypass, which provides bilateral lower extremity revascularization. Furthermore, retrograde flow into the pelvis is also maintained. This combination results in the maximal outflow for an EAB, which correlates with increased long-term patency. Although it is often difficult to determine exactly the technique of EAB performed in other published series, unilateral axillofemoral bypass to each leg is not uncommonly used,[6,8,28] and its expected lower patency rates would increase the risk of major amputation. Finally in our group of patients cross-femoral flow could more often (54.5%) be established with prosthetic material or direct ilioiliac anastomosis because of the higher incidence of underlying aneurysmal disease and the consequent lesser incidence of infected aortofemoral grafts. The ability to use a prosthetic or ilioiliac conduit eliminates the influence of conduit size on patency. As Clagett et al.[39] have recently reported, autogenous cross-femoral grafts are more likely to fail when the caliber of the conduit is suboptimal. We have had this same experience in our total series of infected aortic grafts, in which the cross-femoral conduit failure was 0% for prosthetic conduits, 10% for ilioiliac anastomosis, 15.8% for vein conduits, and 26.7% when endarterectomized superficial femoral artery was used.

Because almost all of the patients in this series initially presented elsewhere and were referred to UCSF for treatment of the SAEF, it is almost certain that these patients represent a selected group who were hemodynamically stable enough to tolerate the delay associated with transfer from another institution. By definition this means that the more hemodynamically unstable patients at higher risk were not included. This would increase the likelihood that we could successfully perform our preferred technique of revascularization before infected graft removal and would also tend to improve overall survival.

It seems clear that consistent use of EAB followed by infected graft removal can currently produce substantially better outcomes than could previously be achieved in the management of secondary aortoenteric fistula. It is against this yardstick that alternative treatment approaches must be measured. The published experience of in situ graft replacement for SAEF consists mostly of small series, with a few cases treated in this manner among a larger group of patients with SAEF treated with a variety other techniques (Table IX). Only two studies used in situ graft replacement exclusively[32,36]; in three additional reports in situ graft replacement accounted for half or more of the treated patients.[16,22,35] Only one study contained more than 10 patients.[36] In that series of 23 patients, there were five early deaths – including two from persistent sepsis and one from persistent sepsis with recurrent fistula – and there were two late deaths caused by rupture of a false aneurysm at the proximal anastomosis, for an overall mortality rate of 30.4%. An additional patient required reoperation to repair

Table IX. Results of in situ graft replacement for aortoenteric fistula

Study	*Study dates*	*Study interval (yr)*	*No.*	*Mortality*			*Follow-up period*	*Stump disruption*	*Reinfection rate*
				Perioperative	*Late*	*Total*			
Selected series									
Kiernan et al.[23]	1964-1978	14	7	3 (42.9%)	1 (14.3%)	4 (57.1%)	NS	1 (14.3%)	0
Flye et al.[20]	1970-1982	12	3	NS	NS	1 (33.3%)	NS	NS	NS
Gozzetti et al.[22]	1960-1982	22	4	2 (50.0%)	0	2 (50.0%)	2.8	2 (50.0%)	NS
O'Hara et al.[3]	1961-1985	24	6	5 (83.3%)	0	5 (83.3%)	NS	NS	NS
Thomas et al.[34]	NS	4	2	0	0	0	3.3	0	0
Salo et al.[18]	1974-1984	10	1	0	0	0	3.0	NS	NS
Moulton et al.[24]	1978-1985	7	2	0	1 (50.0%)	1 (50.0%)	NS	1 (50.0%)	NS
Walker et al.[36]	1972-1985	13	23	4 (17.4%)	3 (13.0%)	7 (30.4%)	5.2	4 (17.4%)	2 (8.7%)
Vollmar et al.[35]	1974-1984	10	7	NS	NS	1 (14.3%)	NS	NS	NS
Umpleby et al.[14]	1980-1984	4	1	0	1 (100%)	1 (100%)	2.0	1 (100%)	NS
Sorenson et al.[32]	NS	NS	1	0	0	0	NS	1 (100%)	NS
Higgins et al.[8]	1977-1987	10	4	0	1 (25.0%)	1 (25.0%)	NS	2 (50.0%)	0
Jacobs et al.[16]	1972-1989	17	7	4 (57.1%)	0	4 (57.1%)	4.3	NS	1 (14.3%)
Robinson et al.[33]	1978-1989	11	4	0	0	0	4.0	0	0
Bergeron et al.[6]	1970-1989	19	1	1 (100%)	0	1 (100%)	NS	0	0
Average		12.6	4.9	19 (30.2%)	7 (11.1%)	28 (38.4%)		12 (24.5%)	3 (6.3%)
Literature review	(28 series)								
Bunt[29]	1952-1982	30	70	NS	NS	41 (58.6%)	NS	NS	NS

NS, Not clearly stated.

a large proximal anastomotic false aneurysm. Two patients were lost to follow-up. Therefore the overall rate of cure or successful treatment was 56.5%. On average all of these studies contained 4.8 patients each, accumulated over an average interval of 13 years (Table IX). The consistent low volume experience with this technique makes it impossible to eliminate the serious potential for sampling error when interpreting the results. To the overall mortality rate of 38% one must also add the additional treatment failures resulting from false aneurysm formation or reinfection of the newly placed graft, sometimes resulting in late death and sometimes requiring reoperation with ultimate resection of the in situ graft and placement of an EAB. In many of the published series this information is not available. When it can be determined it results in an overall success rate that approaches the results in Walker's series.

Finally, it is interesting to note that in situ graft replacement does have an associated incidence of disruption of the proximal aortic suture line that is somewhat greater than the frequency of aortic stump disruption in those patients who have graft removal and oversewing of the aorta (Tables VIII and IX). It is possible that in-line graft replacement may result in less extensive debridement of the aorta, which may allow persistent infection to remain in the aortic wall, leading to false aneurysm formation, with or without recurrent fistulization or rupture. Clearly, then, maintaining aortic continuity by replacing the graft does not eliminate the possibility of aortic disruption, as has been suggested by some authors.[16,34,36]

An additional factor that is believed to influence the outcome after treatment of aortic graft infection is the nature of the infecting organism. In our study group 20 patients had gram-negative organisms recovered from culture of the graft or perigraft tissue, whereas an additional five patients had gram-negative organisms cultured from wound or blood, an overall frequency of gram-negative infection of 75.8%. Because only four cases were entirely culture negative, the cure rate in this series is not likely due to a higher frequency of low-virulence infecting organisms. Furthermore, this distribution of infecting organisms underscores the fact that in situ graft replacement for SAEF can rarely be justified by the experimental data, suggesting some success with in situ replacement for coagulase-negative graft infections.[40]

This series establishes the outcome that can be achieved currently with the standard approach of EAB followed by infected graft removal in the treatment of secondary aortoenteric fistula. The improved results noted in this recent experience are attributed to improved perioperative management; elimination of extended periods of lower body ischemia by routine performance of the revascularization first; routine use of axillobifemoral bypass with preservation of retrograde pelvic flow to provide optimal EAB run-off and thus increase patency; and

routine aggressive debridement of involved artery, perigraft tissue, and retroperitoneum to reduce the risk of persistent retroperitoneal infection or aortic stump disruption.

Obviously not every patient with a secondary aortoenteric fistula will be a candidate for this standard treatment. Inevitably there will be a certain percentage of patients diagnosed with acute hemorrhage and hemodynamic instability who will need a different approach. However, when the clinical circumstances permit—and we believe this will be the case for the substantial majority of patients—the present optimal treatment for secondary aortoenteric fistula consists of revascularization first, followed by IGR.

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DISCUSSION

Dr. G. Patrick Clagett (Dallas, Texas). This study contains a wealth of detail that is strikingly absent from most retrospective studies of aortoenteric fistula. In reviewing the literature, one is continually frustrated by the paucity of hard data that makes comparison between series and methods of treatment impossible.

With regard to the authors' conclusions, I find little with which to disagree. In situ aortic replacement with prosthetic material is occasionally successful but too unreliable to be used except in desperate circumstances. We have used in situ replacement with autogenous tissue fashioned from deep veins and have had a gratifying, less than 10% mortality and amputation rate in more than 30 patients with aortic prosthetic infections. However, in our subgroup of patients with aortoenteric fistula, our results have been less favorable, and we still prefer the standard approach advocated here.

Fourteen patients were excluded from analysis. Can you tell us more about them? By strict intention-to-treat principles, they should be included in your overall experience. What would your mortality rate have been if these were included?

Your patients are obviously a referral population, and this is reflected in the fact that only four required emergency operation. In my own experience, most of these cases are emergencies and occur in the middle of the night. Don't you think that your good results are to some degree due to the referral pattern and selection bias in that these are mostly stable patients?

I am uneasy about staging this operation if true aortoenteric fistula is present. I note that you had one death from exsanguination during the interim between EAB and graft removal. Would you tell us how you decide whether to stage the operation?

Dr. Laurie M. Kuestner. With regard to your first question about the 14 patients who were excluded from the study, the 14 patients consisted of four patients who were transferred to our institution after therapy had been initiated elsewhere. The remaining 10 patients did not undergo standard therapy, and they were excluded on this basis. Four underwent autologous reconstructions, three underwent in situ graft replacement, one patient had an IGR alone without revascularization, another patient had local therapy only, and a final patient exsanguinated during operation without any definitive therapy other than placement of an aortic clamp. It's difficult in a retrospective study to determine the intention to treat. However, we included all patients in whom we believed the intention to treat was EAB and IGR.

In reviewing our 10 patients who were excluded who did not undergo the standard therapy, perhaps the one patient who exsanguinated during operation could be included in our series. This changes the mortality rate from 27% to 29%.

Regarding the second question, I agree that the small number of emergency operations in this series, that is, four, does reflect that our population is mainly a referral population. The fact that only four patients required emergency surgery is a consequence of the patient surviving to be transferred to the university. This represents a selection bias.

With regard to your third question, how we decide whether a patient undergoes staged or sequential repair, it has been our experience that one third of the patients have symptoms of infection only without gastrointestinal bleeding. In these patients, we do not hesitate to proceed with staged repair. In the remaining patients who do have gastrointestinal bleeding, about two thirds are admitted with acute bleeding and the other one third has chronic bleeding or simply guaiac-positive stool. In the latter group of patients with a slow chronic bleed or occult blood in the stool, we proceed with a staged reconstruction. In the patients with acute gastrointestinal bleeding, we usually perform a sequential technique that is EAB followed by IGR with the patient under the same anesthesia.

Dr. John J. Ricotta (Buffalo, N.Y.). It appears that you were able to make the diagnosis of aortoenteric fistula before operation in all of your patients, thus allowing elective placement of an axillary bifemoral graft before abdominal exploration. Can you tell us how you make this diagnosis with certainty? We have found this to be particularly difficult in patients diagnosed with significant hemorrhage. What would you suggest be done when a patient is admitted with hemorrhage and your preoperative evaluation leaves the site of bleeding in doubt?

Dr. Kuestner. You stated that you assumed from our study that all of the patients were known to have an aortoenteric fistula before operation, and you wondered

how we determined this and how we treat the patient when the diagnosis is not clear. Most of the patients were evaluated with an EGD, CT scans of the abdomen, pelvis, and angiography. For the most part, these studies confirmed a graft infection but did not confirm an aortoenteric fistula. All the patients in the series did not have a preoperative diagnosis of an aortoenteric fistula. In fact, only one third had a definitive diagnosis of aortoenteric fistula before operation. Fifty percent of the patients had a suspected diagnosis of aortoenteric fistula that was confirmed during operation; in 15% of patients it was not suspected but was found during operation.

In the patient with significant hemorrhage, we recommend a three-stage approach: first, perform an exploratory laparotomy to control the life-threatening hemorrhage, and then, once the patient's condition is stable, proceed with EAB followed by IGR.

Dr. John E. Connolly (Irvine, Calif.). This study is an important contribution to the management of SAEF. The authors have shown that the mortality rate of the conventional operation for removal of the graft with EAB can be performed with a mortality rate half that commonly reported.

I believe that these improved results can be attributed to several reasons. First, almost all of the authors' cases were nonemergencies; second, in all cases except one, the EAB was performed initially; third, that it was possible to construct the axillary bifemoral grafts into the common femoral arteries in most cases because the original infected grafts entered the external iliac arteries; and last, the operations were carried out by very experienced surgeons. What we now need is comparable long-term data on the alternative treatment of either in situ new graft placement or simple fistula closure.

I note that half of the authors' patients had their original grafts placed for occlusive disease and about half of these were end-to-side aortobifemoral grafts. I suggest that an alternative to graft removal and EAB is to convert the operation to a standard aortoiliac endarterectomy in those cases where that operation was an alternative at the original procedure. I have done that in two cases over the past 20 years. Both were long-term successes. The secret is to examine the original aortogram to determine whether the occlusive disease was suitable for endarterectomy. The aortic and femoral take-off sites are examined at surgery, and if patching appears to be necessary, saphenous vein or hypogastric artery patch material is harvested before clamping the functional bypass to minimize distal flow interruption at the time aortoiliac endarterectomy is performed. This procedure is ideal because all prosthetic graft is removed, and none is added by EAB. Obviously, end-to-end proximal aortic anastomosis precludes such a procedure.

The senior authors of this study (Ehrenfeld WK, et al. Surgery 1978;85:82-92) presented data on the use of autogenous tissue on reconstruction in the management of infected grafts. Therefore I want to ask the authors whether they have ever used the endarterectomy technique for infected aortoenteric fistulas, and if not, what do they think of its possible use?

Dr. Kuestner. You stated that the senior authors of this study had presented a report 15 years ago discussing the use of autologous reconstruction for infected grafting. During the time when this series was collected, there were four patients who underwent autologous reconstruction. The series reported by the senior authors only included two patients with aortoenteric fistula. We prefer EAB and IGR in treating these patients.

Dr. Averill Mansfield (London, United Kingdom). My colleague, John Wolfe, and I deal with this problem in an almost identical way and strongly support the approach rather than the increasingly popular conservative management. In our own series, there are a number of patients who have undergone previous conservative measures and all of them had spent a significantly greater number of days in the hospital and had a larger number of procedures before the definitive excision.

The question is how to resolve the dilemma about which of these two modes of management would be best in an individual. Do you believe it would be feasible to do a randomized trial of these two alternative management regimens?

Dr. Kuestner. You asked if there is any way to create a prospective study to support our recommendation of EAB and IGR. Our response is that the incidence of aortoenteric fistula is extremely low, that is, 0.36% to 1.6% of patients who undergo aortic prosthetic grafting, so collecting a large series is quite difficult. To perform a prospective study, a multicenter trial would be needed.