Impending Aortoenteric Hemorrhage

The Effect of Early Recognition on Improved Outcome

GARLAND D. PERDUE, JR., M.D., ROBERT B. SMITH, III, M.D., JOSEPH D. ANSLEY, M.D., MARK J. COSTANTINO, M.D.

Aortoenteric hemorrhage is the result of enteric erosion and necrosis of aortic wall or anastomotic site. Mechanical or bacteriologic causes may occur singly or in combination. The temporal sequence is such that warning symptoms, often including back pain, fever, hemotochezia, and anemia, are present long before exsanguinating hemorrhage occurs. Vigorous diagnostic efforts, including gallium-67 citrate nuclear scan and computerized axial tomography, lead to a correct diagnosis. This allows planned semielective corrective operation before severe hemorrhage begins. The ideal operation consists of extra-anatomic revascularization, excision of the infected prosthesis, bowel repair with decompression, and sump drainage. Appropriate antimicrobial therapy should be continued until healing is complete. With aggressive diagnostic and therapeutic intervention according to this plan, marked improvement in survival and limb preservation can be anticipated in patients having this complication of aortic surgery. In this series, 15 of 18 patients having operation recovered, though delayed limb loss occurred in two.

THE CHALLENGE OF SUCCESSFUL treatment of the patient with massive hemorrhage due to aortoenteric fistula is not well met. The effect of delayed recognition, urgent operation on patients in shock, and retroperitoneal sepsis, is a mortality rate expectancy of around three of four patients, with limb loss in some of the survivors.[2,4,5,8,9,11,12] Incomplete acceptance of the principles of extra-anatomic revascularization compounds the problem. It seems reasonable that more alert diagnosis and aggressive intervention before onset of massive hemorrhage, with adherence to the principles of excision of the foreign prosthesis and extra-anatomic revascularization,[7,13,20] might lead to improved outcomes. A retrospective review of patients treated at Emory University Hospital from 1972 through early 1979 is presented as a means of evaluation of this hypothesis.

Reprint requests: Garland D. Perdue, M.D., Professor of Surgery, Emory University School of Medicine, Atlanta, Georgia 30322.

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From the Joseph B. Whitehead Department of Surgery Emory University School of Medicine, Atlanta, Georgia

Clinical Material and Case Reports

Twenty-two patients had 23 paraprosthetic complications with actual or impending hemorrhage. Four patients were treated expectantly without operation and 18 patients had 19 operations for treatment. The case histories of the expectantly treated patients are outlined to illustrate the sequence of events in the natural evolution of this complication.

Case 1. A 70-year-old man, had a ruptured 15 cm aortic aneurysm successfully treated by aneurysmectomy and restoration of vascular continuity with a 22 mm knit Dacron® bifurcation prosthesis. Technical difficulties were noted in the operative report but were not specified, other than for the large size of the aneurysm and intraoperative hemorrhage. After five years he began to have intermittent back and flank pain. Melena and anemia were present. He had chronic congestive heart failure, and senile dementia to the point that he was psychotic, with belligerent and uncontrollable behavior. Barium roentgenography of the gastrointestinal tract and intravenous urography were normal. Aortography indicated expansion of the vascular prosthesis to 42 mm in diameter. A diagnosis of impending aortoenteric communication was considered probable. Operative intervention was deferred because of the chronic physical limitation and the severity of psychosis. Intermittent episodes of recurrent pain and low grade fever occurred during the next 11 months. The final episode began with hematochezia followed by massive gastrointestinal hemorrhage and death. The presence of aortoduodenal fistula was confirmed at autopsy.

Case 2. A 67-year-old man, had aneurysmectomy and restoration of vascular continuity with a 22-mm Dacron prosthesis seven years previously. He had active pulmonary tuberculosis, and vertebral body erosion associated with the aneurysm. Culture and smear specimens of the aneurysm were negative, however, and recovery was uncomplicated. Subsequently, he had multiple episodes of diverticulitis, and on one occasion had gangrenous cholecystitis with multiple complications and Klebsiella sepsis. Septic pulmonary emboli culminated in empyema and the patient developed severe limitation of activity due to cor pulmonale. Seven years after aneurysmectomy and one year after Klebsiella sepsis he began to have chronic back pain and recurrent episodes of low grade fever. Multiple diagnostic

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studies were normal with the exception of aortography, which showed a small anastomotic aneurysm. Operative intervention was deferred because of the patient's severe multiple illnesses including acute myocardial infarction after aortography. He was observed intermittently for 13 months, when he had massive gastrointestinal hemorrhage and died. Autopsy confirmed the presence of a small anastomotic aneurysm and communication between the aorta and the duodenum. Klebsiella was cultured from the aneurysm.

Case 3. A 71-year-old woman had a ruptured abdominal aneurysm treated by aneurysmectomy and restoration of vascular continuity with a 22 mm Dacron prosthesis. The procedure was described as technically difficult. Her postoperative course was complicated by myocardial infarction and a urinary tract infection due to Klebsiella. After four years, recurrent back pain occurred. Gastrointestinal roentgenography showed a duodenal ulcer and myelography showed a herniated nucleus pulposus. Recurrent back pain and fever led to additional study. Aortography was normal but a gallium-67 citrate scan showed an apparent paraprosthetic abscess. Blood and urine cultures grew Klebsiella. The patient and her husband were extremely reluctant to consider surgical treatment because of angina decubitus and chronic congestive heart failure, and operation was deferred. Massive gastrointestinal hemorrhage and death occurred one week after the diagnosis and one year after onset of intermittent pain and fever. Aortoduodenal communication was confirmed at autopsy.

Case 4. A 73-year-old man had a Dacron aortofemoral bypass for occlusive disease. His postoperative course was complicated by a superficial would infection in the abdominal incision due to *Staphylococcus aureus*. The patient returned after eight years with serous drainage from the left groin. Injection of contrast media into the sinus tract showed communication with the retroperitoneal paraprosthetic space, and a gallium-67 citrate scan confirmed the presence of an inflammatory reaction with increased uptake in this area. The patient adamantly refused operation because of the fear of potential limb loss. Intermittent pain and fever continued for eight months, when hematochezia and external hemorrhage occurred and the patient died at home.

Comment

In each of these instances a diagnosis of impending aortoenteric hemorrhage was made but an operation was not performed because of comorbidity or because the patient declined. Excessively large prostheses, aneurysmal dilatation of the prosthesis, or anastomotic aneurysm, may have contributed to the enteric erosion in some. Infection harbored from the time of the original surgery or acquired from intercurrent sepsis or enteric erosion undoubtedly contributed in others. Terminal exsanguination came 8–13 months after onset of symptoms and after the correct diagnosis had been made for each patient.

Operative Case Material

Eighteen patients were treated by operation in 19 instances for suspected paraprosthetic infection and impending aortoenteric communication. Individual data concerning these and the untreated patients are indicated in Table 1. There were 19 men and three women whose ages ranged from 44 to 76 years (mean: 60 years). Only one of the patients presented with massive gastrointestinal bleeding (Patient 10, Table 1), the remainder having had a variety of symptoms for an average of three months prior to operative intervention or hemorrhage. Eighteen of the 22 had melena or hematochezia leading to anemia, while the remainder had lumbar back pain, fever, or external drainage from an enterocutaneous fistula.

The anatomic findings are summarized as follows: Ten patients had actual aortoenteric communication and six others had enteric erosion but without disruption of the aortic wall or suture line (paraprosthetic enteric fistula). Six patients had paraprosthetic infection without demonstrable enteric communication. Several of these had melena and anemia, and two had an anastomotic aneurysm. Two patients with enteric erosion developed thrombosis within the prosthesis and one patient with paraprosthetic infection had thrombosis of the prosthesis. It is of interest that bowel erosion in two of six patients was firmly sealed against the prosthesis without paraprosthetic fluid collections. In three instances, paraprosthetic fluid collections did lead to inguinal drainage and two of these patients were demonstrated to have enterocutaneous fistula.

Possible predisposing causes are multiple. Enteric erosion clearly resulted from inadequate reperitonealization in four patients, two of whom had intraperitoneal prostheses. Infection probably played a major role in causing many of the others. Definite postoperative wound infections were noted in two patients and suspected residual infections in four others. Bowel trauma may have caused contamination leading to infection. This was known to have occurred in two patients and the frequency of ruptured aneurysms, multiple operations, and unspecified technical difficulties, conditions all of which may have predisposed to operative bowel trauma and infection, is noteworthy. Only one patient had no identifiable feature likely to contribute to paraprosthetic infection or enteric erosion. The probability of bowel trauma or erosion as the source for bacterial organisms recovered is illustrated by the frequency with which enteric organisms were encountered. Two patients with operative infections had *S. aureus* and in four others, a *S. epidermidis* was recovered. Low grade variants of the latter may account for prolonged delay in the presentation of manifestations of paraprosthetic infection.

No single diagnostic method yielded consistently positive results with the exception of gallium-67 citrate scanning. This diagnostic method was not used throughout the study period but was positive in all instances in which it was elected. A strong presumptive diagnosis led to laparotomy in five patients, one of whom was known to have thrombosis of the prosthesis. It is noteworthy that in every

instance, complete dissection of the duodenum and jejunum away from the aortic prosthesis was necessary to confirm the existence of enteric erosion or aortoenteric fistula, since this was not apparent without such complete dissection. Aortography was most useful in confirming the presence of anastomotic aneurysm or thrombosis of the prosthesis. Contrast injection of the sinus tract, when present, confirmed extension to the retroperitoneal paraprosthetic space and in two instances demonstrated enteric communication. Scanning by computerized axial tomography was confirmatory in two instances and preoperative blood cultures were occasionally positive. Barium roentgenography of the gastrointestinal tract was normal in all but one patient, and endoscopy was noteworthy for the frequency with which it failed to reveal the correct pathology. A summary of yield of the diagnostic methods used is indicated in Table 2.

The ideal operation was considered to be extra-anatomic revascularization, excision of the prosthesis, closure of the aortic stump to prevertebral fascia and suture of the distal stump, and bowel closure with decompression by enterostomy. An omental flap was interposed between duodenum and aortic stump. When paraprosthetic suppuration was present, sump drainage was established. While each operation was somewhat individualized, 14 patients were considered to have this "ideal" operation. Thirteen of these survived without limb loss. Operation in one patient was delayed because of comorbidity and massive hemorrhage occurred. While the operation was completed successfully, this patient did not recover from the effects of the hemorrhagic shock. Two patients had autogenous tissue repair without extra-anatomic revascularization after excision of the prosthesis and closure of the duodenum.

In five instances a compromise operation was performed. One of these patients died of hemorrhagic shock before the operation could be completed. In four patients an attempted *in situ* repair was done. One of these patients (Patient 2, Table 1) was thought to be nearly moribund and *in situ* repair was done as an expedient to terminate the operation. The patient not only survived, but had prompt recurrence and survived a second operation for ideal repair. One patient (Patient 5, Table 1) had an excessively large prosthesis with paraprosthetic sepsis. There was minute bowel penetration with melena. Excision and replacement of the prosthesis, interposition of omentum, and irrigation with topical antibiotics was elected. This patient recovered and has been followed for 84 months. *In situ* repair was elected in another patient (Patient 11, Table 1) because of a minute penetration of bowel and aorta. The patient did not bleed but died of recurrent sepsis after several months. In the final instance (Patient 12, Table 1) thrombosis of the prosthesis had occurred and the duodenal erosion was firmly sealed without paraprosthetic fluid collection. Subclavian atherosclerosis precluded satisfactory axillofemoral bypass and replacement of the prosthesis *in situ* was elected in view of the minimal contamination. This patient has been followed nine months with no evidence of complication.

Thus, 15 of 18 patients (19 operations) did recover, a salvage rate of 83% of those patients having operation. (When four patients not having operation are included, the survival was 68%.) Two survivors, however, did subsequently require limb amputation because of inability to maintain satisfactory revascularization. Also, several patients have required thrombectomy of the axillofemoral revascularization and two patients (Patients 6 and 19, Table 1) have recently had conversion to aortofemoral bypass after multiple problems with the axillofemoral revascularization over a period of five years. Interestingly, all survivors of the complication are still living at the time of this report, except Patient 22 who died of carcinoma of the lung after five years.

Discussion

The sequence of events from initiation to maturation of an aortoenteric communication is not completely clear in every patient. We subscribe to the view that both mechanical factors[4,6,8,11,13] and infection[2,3,6,11,13] may each play the major role and are often combined. A necessary precondition appears to be adherence of adjacent bowel to the blood vessel or prosthesis. The propensity of aorta adherent to duodenum to erode the bowel is illustrated by numerous reports of isolated instances of such an event since Cooper's original report in 1829. (We have observed several patients with primary aortoenteric fistula, not the subject of this report.)

In this series four instances of inadequate reperitonealization were noted, including two patients who had an intraperitoneal prosthesis. Anastomotic aneurysms, whether the result of technical fault or low grade infection, probably add to the likelihood of adherence of bowel to the pulsating organ. Fragmentation of suture materials, particularly silk, has been implicated, but was not observed in this series. Failure to properly place sutures through all layers of the aorta may also result in anastomotic bleeding and aneurysm formation. When the aorta is transected, it is helpful to incorporate a layer of Teflon® felt in the aortic suture to seal suture holes firmly and prevent tearing of the suture through the aorta. Almost 25% of our patients had anastomotic aneurysms. An excessively

TABLE 1. *Case Summaries*

Patient Number	Previous Vascular Procedure(s)	Interval	Symptoms and Duration	Primary Diagnostic Method	Findings	Bacteriologic Findings	Possible Predisposing Causes	Operation	Outcome & Duration of Follow-up
1	Aneurysmectomy	10 mo	Fever, melena, hematochezia (1 mo)	Gallium-67 scan	AE fistula	Mixed enteric flora	Inadequate reperitonealization	AxF bypass, excision prosthesis, closure duodenum, enterostomy	Recovered 18 mo
2	Aneurysmectomy	5 mo	Back pain, fever (2 mo)	Arteriography	False aneurysm, infected	Mixed enteric flora	Operative trauma duodenum	Excision, replacement of prosthesis *in situ*	Recurrence 2 mo
2a	1 aneurysmectomy 2 excision false aneurysm	2 mo	Pain, fever, hematochezia (2 mo)	Barium enema	Aortocolic fistula	Mixed enteric flora	Infection	AxF bypass, excision prosthesis, colostomy—closure colostomy	Recovered 75 mo
3	AF bypass	36 mo	Pain, fever, melena, anemia (12 mo)	Gallium-67 scan	Enteric erosion	Mixed enteric flora	Inadequate reperitonealization	AxF bypass, excision prosthesis, closure duodenum and jejunum, enterostomy	Recovered 30 mo
4	AF bypass	18 mo	Pain, melena, anemia, inguinal seroma (2 mo)	Contrast injection of sinus	Enterocutaneous fistula	*S. epidermidis*	Inadequate reperitonealization	Closure duodenum, *in situ* prosthesis with distal limb via obturator fossa, enterostomy	Recovered 78 mo
5	Aneurysmectomy (ruptured)	2 mo	Pain, fever, melena, severe anemia (2 mo)	Laparotomy	Enteric erosion, paraprosthetic hematoma	Klebsiella	Ruptured aneurysm; remote sepsis (intercurrent gangrenous cholecystitis)	Closure duodenum, enterostomy, omental flap, *in situ* replacement prosthesis	Recovered 84 mo
6	1 exploratory laparotomy, 2 aneurysmectomy	3 mo	Fever, pain, melena, anemia (2 mo)	Aortography	False aneurysm, paraprosthetic infection	Hemophilus	Possible mycotic aneurysm; morbid obesity; prior exploration	AxF bypass, excision prosthesis, omental flap	1 thrombectomy two times 2 anastomotic aneurysm 3 recovered 60 mo
7	1 iliofemoral bypass 2 AF bypass	7 mo	Fever, inguinal abscess, melena, anemia (1 mo)	Contrast injection of sinus	Ileocutaneous fistula, ureterocutaneous fistula	Mixed enteric flora	Operative trauma; multiple operations	AxF bypass, excision prosthesis, closure ileum, sump drainage	Recovered 24 mo
8	AI bypass	30 mo	Inguinal sinus, hemorrhage (2 mo)	Laparotomy	AE fistula	*S. epidermidis*	Indeterminate	Excision prosthesis, AxF bypass, Omental flap	Recovered 30 mo
9	1 AF bypass 2 thrombectomy	130 mo	Back pain, fever, hematochezia (1 mo)	Laparotomy	AE fistula	*E. coli*	Multiple operations	Excision prosthesis, AxF bypass, closure duodenum, enterostomy	Recovered 20 mo
10	Aneurysmectomy	2 mo	Fever, pain, hematemesis, hematochezia (1 mo)	Gallium-67 scan	AE fistula	Unknown	Prior irradiation for Hodgkin's disease	AxF bypass,* excision prosthesis, closure duodenum	Died: shock
11	Aneurysmectomy (ruptured)	16 mo	Pain, fever, melena, anemia (3 mo)	CAT scan	AE fistula	Mixed enteric flora	Ruptured aneurysm, prednisone therapy (severe lung disease)	*In situ* repair, closure duodenum, enterostomy	Died: sepsis
12	1 AI endarterectomy 2 AF bypass 3 thrombectomy	48 mo 24 mo 2 mo	Melena, anemia, recurrent thrombosis (1 mo)	Aortography, laparotomy	Duodenal erosion, thrombosis of prosthesis	Mixed enteric flora	Multiple operations; inadequate reperitonealization	Closure duodenum omental flap, replacement of prosthesis *in situ*	Recovered 6 mo
13	1 AI endarterectomy 2 AI prosthesis	120 mo 24 mo	Pain, fever, melena, anemia, thrombosis (1 mo)	CAT scan, aortography	Duodenal erosion, thrombosis of prosthesis	Enterobacter	Multiple operations	Closure duodenum, excision prosthesis, autogenous tissue repair, enterostomy	Recovered 3 mo
14	Aneurysmectomy (ruptured)	60 mo	Back pain, melena, hematochezia (11 mo)	Aortography	AE fistula	Unknown	Ruptured aneurysm	No operation: 1 uncontrollable psychosis, dementia 2 chronic congestive heart failure	Exsanguinated 11 mo

TABLE 1. (*Continued*)

Patient Number	Previous Vascular Procedure(s)	Interval	Symptoms and Duration	Primary Diagnostic Method	Findings	Bacteriologic Findings	Possible Predisposing Causes	Operation	Outcome & Duration of Follow-up
15	Aneurysmectomy (ruptured)	46 mo	Pain, fever, anemia, hematochezia (13 mo)	Gallium-67 scan	Paraprosthetic infection; AE fistula	Klebsiella	Ruptured aneurysm; remote sepsis (urinary tract infection)	No operation: patient declined; had intractable angina, chronic congestive heart failure	Exsanguinated 13 mo
16	Aneurysmectomy	84 mo	Pain, fever, melena, hematochezia hematemesis (10 mo)	Aortography	False aneurysm; AE fistula	Klebsiella	Debilitated due to multiple illnesses; remote sepsis (intercurrent gangrenous cholecystitis)	No operation: renal failure; chronic cor pulmonale	Exsanguinated 10 mo
17	Aneurysmectomy	99 mo	Inguinal abscess, hematochezia, external bleeding (8 mo)	Contrast injection sinus tract, gallium-67 scan	Paraprosthetic infection	*S. epidermidis*	Possible residual infection (wound infection at original surgery)	No operation: patient refused for fear of limb loss	Exsanguinated 8 mo
18	Aneurysmectomy (ruptured; suspected mycotic)	7 mo	Pain, hematochezia, hematemesis (2 mo)	Aortography	False aneurysm; AE Fistula	Bacteroides	Ruptured aneurysm (possibly mycotic)	Excision aneurysm	Died: shock
19	1 AF bypass 2 thrombectomy	30 mo 30 mo	Pain, fever, thrombosis (6 mo)	Aortography, laparotomy	Thrombosis, paraprosthetic infection	Bacteroides	Multiple operations	AxF bypass, excision prosthesis	BK amputation Recovered 36 mo
20	AF bypass	3 mo	Fever, pain (1 mo)	Aortography	False aneurysm; paraprosthetic infection	*S. aureus*	Infection	Excision prosthesis; autogenous tissue repair	Recovered 24 mo
21	1 AF bypass 2 anastomotic aneurysmectomy, 3 thrombectomy	60 mo	False aneurysm, inguinal abscess (6 mo)	Aortography, contrast injection of sinus tract	Paraprosthetic infection	*S. epidermidis*	Multiple operations	AxF bypass, excision prosthesis	Multiple thrombectomy, AK amputation Recovered 60 mo
22	Aneurysmectomy (ruptured)	5 mo	Inguinal sinus, external bleeding (3 mo)	Contrast injection of sinus tract	Paraprosthetic infection	*S. aureus*, pseudomonas	Ruptured mycotic aneurysm	Excision prosthesis, axillopopliteal bypass	Recovered 60 mo

* Operation delayed.
AxF = Axillofemoral.
AF = Aortofemoral.
AI = Aortoiliac.
AE = Aortoenteric.
AK = Above knee.
BK = Below knee.

large prosthesis may play a role in some patients. Four of our 22 patients had a prosthesis 22 mm or larger in diameter and one of these patients had progressive dilatation. Use of such a large prosthesis at least creates some increased difficulty in adequate tissue coverage.

It follows from observation of these mechanical factors that when adequate interposition of tissue between the aorta or prosthesis and the duodenum or jejunum is done, there should be less likelihood of aortoenteric communication even in the presence of anastomotic aneurysm or paraprosthetic infection. Miller[15] has advocated avoidance of replacement of the duodenum after its lateral dissection to expose the aorta. There is usually sufficient paraaortic tissue to permit closure of the retroperitoneum without bringing the duodenum to overlie the aortic prosthesis. The residual aortic wall may be used after aneurysmectomy. When difficulty is encountered it is relatively simple to create a flap of omentum sufficient to be used to cover the prosthesis. Since these technical factors are clearly under the control of the surgeon it is important to stress technical perfection in creation of the suture line and in the coverage of suture line and prosthesis to avoid contact with the bowel.

The second major factor in development of actual or impending aortoenteric hemorrhage is the occurrence of infection involving the arterial suture line or the paraprosthetic space. Elliott, Smith, and

TABLE 2. *Sensitivity of Diagnostic Examinations*

Diagnostic Procedure	Number Performed	Number Positive	Per Cent Sensitivity
Gallium-67 citrate scan	5	5	100
CAT scan	4	4	100
Endoscopy	8	3	38
Aortography	18	6	33
Barium roentgenography	13	1	8
Ultrasonography	3	0	0

Szilagy,[8] and O'Mara and Imbembo[17] have stressed the occurrence of paraprosthetic enteric fistula. These problems are well illustrated in this series where several patients with enteric paraprosthetic communication and even enteric cutaneous fistulae passing adjacent to the prosthesis were observed. The origin of this infection may be obscure. It is possible that infection is harbored in the space adjacent to the prosthesis from the time of operative contamination. Such contamination may be from the environment and the occurrence of *S. aureus* and *S. epidermidis* suggest this possibility. In many other patients the organisms recovered are pathogens indigenous to the gastrointestinal tract. Therefore, it is reasonable to speculate that enteric contamination at the time of operations may have contributed to the paraprosthetic infection. Similarly, enteric erosion with transmural migration of bacteria might produce paraprosthetic suppuration. Enteric injury at the time of operation was known to have occurred in two of the patients in this series. It is also interesting to consider the possibility of unrecognized enteric injury associated with technically difficult operations. The frequency of ruptured aneurysms in this and other series is noteworthy as is the frequency of multiple operations. Both of these conditions undoubtedly contribute to a greater likelihood of unrecognized enteric injury and contamination at the time of initial operation. The relatively long period of time intervening between such contamination and eventual manifestation of paraprosthetic infection in many patients is not surprising in view of the relatively low pathogenicity of some of the organisms encountered. The presence of the foreign body and incomplete incorporation of surrounding tissue when woven prostheses are used are probable important considerations in the maintenance of a prolonged, smoldering, low grade infection.

Busuttil, et al.[2] and Rosenthal, et al.[19] have stressed the importance of infection involving the aorta to prosthesis suture line. This was demonstrably the case in several of the patients in this series, and such infections may have caused the anastomotic aneurysms seen in others. Bacterial contamination at the time of operation or from early postoperative bacteremia undoubtedly plays a role in this. The offending organisms may be harbored at the aortic suture line or in the paraprosthetic space until low grade infection causes disruption of the suture line with extrusion of the foreign material or penetration of adjacent bowel. The role of intercurrent sepsis may be greater than has been generally appreciated. Incomplete healing of the anastomotic suture line may result in implantation of bacteria when bacteremia occurs from any source. In two of the patients in this series intercurrent sepsis due to Klebsiella was clearly identified and the subsequent development of Klebsiella infections at the aortoenteric fistula is highly suggestive of this probability. The role of antimicrobial prophylaxis for illness or procedures likely to result in bacteremia is not clearly defined but is at least a reasonable consideration.

Enteric erosion and paraprosthetic infection may result in thrombosis of the prosthesis so that hemorrhage may be averted or long-delayed. This is clearly the exception rather than the rule.

We infer that whether from enteric erosion or paraprosthetic infection, aortic necrosis or disruption of the suture line is likely to occur, with development of an aortoenteric fistula. This sequence of events strongly suggests a significant interval of time during the pathogenesis of the mature fistula when symptoms may be present but before massive hemorrhage occurs. Garrett, et al.[9] pointed out in 1963 that massive hemorrhage is usually preceded by minor bleeding by hours or days. The inference is clear that if presenting manifestations are recognized and vigorous diagnostic measures instituted, patients with impending aortoenteric hemorrhage can be identified when it is possible to intervene under relatively controlled circumstances and before the onset of exsanguinating hemorrhage. There is often a symptomatic interval of weeks or months duration before the onset of major bleeding.[8,13,14,18] Most important of these presenting symptoms are the occurrence of intermittent abdominal and back pain often associated with low grade fever, hematochezia and chronic anemia. The occurrence of these symptoms in any patient with a retroperitoneal vascular prosthesis warrants intensive diagnostic efforts to substantiate the suspected diagnosis before major hemorrhage occurs. Only one patient in this series had massive hemorrhage without prior warning. It is important to recognize, however, that after the occurrence of the sentinel hemorrhage, recurrent bleeding is likely to ensue within a few hours or days at most. Delay in operative intervention is unwise even if diagnosis must be confirmed by exploratory laparotomy and retroperitoneal dissection.

It appears likely that an aggressive attempt at early diagnosis will be fruitful. Barium roentgenography and angiography are not likely to yield the correct diagnosis, through an anastomotic aneurysm is visible.[21,22] Endoscopy[1,13,16] may be helpful in many instances but unless the endoscopist can readily visualize the fourth portion of the duodenum and proximal jejunum, the most common areas of erosion will be missed. Moreover, proximal pathology may be incorrectly identified as the cause of symptoms leading to incomplete examination. Thus, the more

conventional diagnostic methods have not been uniformly reliable in identifying the correct diagnosis. More recently, computerized axial tomography[10] has been recommended as useful and this has been confirmed in some of the patients seen during the latter part of this series. It is our observation that the interpretation of computerized axial tomography is sometimes equivocal but thus far some suspicion of an abnormal finding has been present in every patient examined. Gallium-67 citrate scans have been even more reliable in indicating an area of increased uptake corresponding to the site of impending or actual enteric erosion or paraprosthetic infection. The prosthesis itself does not appear to pick up the isotope unless associated with such inflammation.

A reasonable diagnostic plan based on clinical presentation and a high degree of suspicion would suggest that gallium-67 citrate scanning or computerized axial tomography would be most likely to be confirmatory. Endoscopy may be useful in some instances provided complete visualization can be achieved. Angiography is probably desirable for proper planning of a proposed operation. When laparotomy is done, it is essential that full mobilization of the aorta and duodenum be accomplished since inspection and palpation of the anterior wall of duodenum and jejunum may appear perfectly normal and the erosion of the posterior wall missed unless the duodenum is completely reflected.[13]

The ideal plan of treatment based on established preoperative diagnosis would appear to include the following steps in sequence: 1) Alternate revascularization by axillobifemoral bypass, unless laparotomy is required initially to confirm the diagnosis, when this step is done last. 2) Laparotomy and excision of the infected prosthesis. The infrarenal aortic stump should be sutured incorporating prevertebral fascia for additional strength. The distal aorta or iliac arteries may be oversewn. 3) Occasionally the severity of erosion of bowel may require limited resection with anastomosis. In most instances, suture repair of areas of penetration would be acceptable. This repair may be re-enforced by interposition of omental flap adjacent to the repair and between it and the sutured aortic stump. 4) Bowel should be decompressed by tube enterostomy and gastrostomy. If nutritional deficiency exists, enteric nutrition can be provided through the distal tube enterostomy. 5) If suppuration is severe, sump drainage of the retroperitoneal space should be established through the flanks. 6) Antimicrobial therapy based on sensitivity of the organisms recovered should be continued for a minimum of three weeks. 7) Replacement of the prosthesis *in situ* or repair *in situ* is associated with excess hazard and should rarely be done.[13] The fact that some patients in this series had minimal contamination with sealed or minute perforations of bowel and did have *in situ* repair with recovery should be considered as exceptional.

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