ORIGINAL ARTICLE

Aggressive Management of Nonocclusive Ischemic Colitis Following Aortic Reconstruction

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Hypothesis: Under standard conditions following aortic reconstruction, nonocclusive ischemic colitis (IC) type 1 (mucosal ischemia) and type 2 (mucosal and muscularis ischemia) can be managed nonoperatively, whereas type 3 (transmural ischemia) requires emergency surgery. Our objective was to standardize the surgical approach for IC complicating aortic reconstruction.

Design: Retrospective cohort study.

Setting: General surgery, vascular surgery, anesthesiology, and critical care units in a university-affiliated hospital.

Methods: From January 5, 1997, to December 15, 2003, 49 cases of IC complicating aortic reconstruction were diagnosed (rate, 2.7%). Nonoperative management was used for patients with type 1 or type 2 without multiple organ failure (MOF). All patients with type 3 or with type 2 with MOF underwent urgent resection of the ischemic colon without anastomosis.

Results: Immediate surgery was performed on 24 patients (49.0%). Nineteen (76.0%) of 25 patients without MOF and with transient endoscopic findings underwent secondary surgery for progression to final IC type 3 (16 patients) or to final IC type 2 with MOF (3 patients). Twenty-three (53.5%) of 43 patients died after colorectal resection (overall mortality, 46.9%). Factors causing significant risk of death were surgery, MOF, final IC type, and amount of perioperative transfusion. The mortality was 57.1% for final IC type 3, 37.5% for final IC type 2 with MOF, and 0% for final IC type 1 or type 2 without MOF.

Conclusions: Selective management of postoperative IC, based on MOF and the degree of ischemia, is the suggested course of action. For patients with mild ischemia and MOF, an aggressive approach is recommended.

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ISCHEMIC COLITIS (IC) IS A RARE but severe complication following aortic reconstruction. Its estimated incidence rate is 2% to 3%[1,2] and is higher after abdominal aortic aneurysm repair than after reconstruction for occlusive disease.[3] The following 3 forms of IC have been described[4] based on the severity of ischemia and the thickness of the bowel wall concerned: type 1 (mucosal ischemia, transient and mild), type 2 (mucosal and muscularis ischemia, generally considered reversible but possibly linked to multiple organ failure [MOF]), and type 3 (transmural ischemia, nonreversible and resulting in necrosis and colic perforation, frequently with MOF). Morbidity and mortality depend on the severity of colonic ischemia and the presence of shock, ranging from almost 0% for type 1 to 60% to 100% for type 3 with MOF. While type 1 can be managed nonoperatively and type 3 always requires emergency surgery, the approach for type 2 is subject to debate. The objectives of this study were (1) to assess the management of 49 consecutive cases of IC (including 11 cases of type 2) following aortic reconstruction during a 7-year period in a single center according to endoscopic features and clinical status and (2) to discuss an aggressive and standardized approach.

METHODS

PATIENTS

From January 5, 1997, to December 15, 2003, 1786 aortic reconstructions were performed, including the implantation of 324 endovascular prostheses. All patients with postoperative complications were admitted to the surgical intensive care unit, where extensive clinical and bacteriological data were collected prospectively on a computerized database. For the present study, medical records were retrospectively reviewed to identify patients with postoperative nonocclusive IC (patients with acute mesenteric ischemia and mesenteric venous thrombosis were excluded from the analysis).

The final diagnosis was based on results of endoscopy or surgery, when performed. Routine colonoscopy was not carried out systematically but was limited to patients with MOF, abdominal mottling, unexplained fever, abdominal distension with pain, or early postoperative bloody or nonbloody diarrhea.[5] The diagnosis

of MOF was established in the case of an unstable hemodynamic status requiring increased doses of vasoactive drugs, persistent renal or respiratory failure, persisting signs of sepsis, or worsening liver test results. Attempts to prepare the colon for endoscopy were limited to mechanical cleansing. Endoscopy was performed at the bedside in the surgical intensive care unit using a flexible endoscope. A 30-cm endoscopy was considered sufficient because 95% of IC following aortic reconstruction affects the sigmoid colon.[6] The endoscopic examination was stopped at the first sign of ischemia. No biopsy specimens were obtained, and IC was visually classified as type 1 (mucosal ischemia), type 2 (ischemia involving the muscularis layer), or type 3 (transmural ischemia, gangrene, and perforation). A helical computed tomographic scan was performed when the patient's clinical condition allowed transportation to the radiology department. Computed tomographic findings suggesting IC were a thickening of the colon wall, a limited area of poor vascularization of the colon wall, a "target" sign with concentric rings, and the presence of intramural or portal venous gas or of free intraperitoneal air.[7] For each patient, the Sepsis-Related Organ Failure Assessment score was calculated.[8] This score, ranging between 0 (best) and 24 (worse), was developed to quantify the severity of MOF and provides a good estimate of outcome and response to treatment in critically ill patients with organ dysfunction. It is composed of scores from 6 organ systems, graded from 0 to 4 according to the degree of dysfunction. Organ systems considered in the Sepsis-Related Organ Failure Assessment score include the respiratory (partial pressure of oxygen/fraction of inspired oxygen), cardiovascular (blood pressure and vasoactive drugs), renal (serum creatinine level and diuresis), hematological (platelet count), neurological (Glasgow Coma Scale score), and liver (serum bilirubin level) systems. Biochemical markers were not used for IC diagnosis because, to date, none has been proved to be specific.

All patients were given a course of nonoperative management with bowel rest, broad-spectrum parenteral antibiotics, and resuscitation with intravenous fluids. This treatment was limited to patients with type 1 and with type 2 without MOF. All patients with type 3 or with type 2 with MOF underwent emergency surgery for resection of the ischemic colon without anastomosis and, since 1999, a prophylactic cholecystectomy to prevent the postoperative onset of acute acalculous cholecystitis. The extent of colonic resection was based on examination and palpation to assess colon viability. In cases in which IC was limited to the sigmoid, a left colectomy was performed to remove the critical area of the splenic flexure, with closure of the rectal stump and introduction of a transverse colostomy. A sigmoidectomy using the Hartmann procedure was performed on 1 patient who had an in situ aortic allograft replacement wrapped in the omentum vascularized with a left-sided gastroepiploic artery. When IC was extensive or when doubts remained about colon viability, a total colectomy with closure of the rectal stump and end ileostomy was performed. Only 1 patient with limited right-sided colonic involvement underwent a right colectomy with a double stoma. The presence of rectal ischemia required as low a resection as possible. During bowel resection, mesenteric dissection was performed distally to prevent exposure and contamination of the aortic prosthesis. Suction drains were placed in the pelvis and abdomen. All colectomy specimens were reviewed by pathologists. Complications that occurred during the hospital stay were recorded as in-hospital morbidity or mortality.

STATISTICAL ANALYSIS

Results are reported as median (range) or as mean ± SD. The primary outcome measure was mortality. Surviving and nonsurviving patient groups were compared using the χ^2 test or *t* test when appropriate. Univariate logistic regression analysis was used to estimate the relationship between mortality and the following variables: sex, age, outcomes, MOF, reoperation, complications, initial and final IC types, needs for surgery, extent of colectomy, primary aortic disease (emergency or planned), transfusion of perioperative red blood cells for aortic reconstruction, delay caused by diagnosis of suspected IC and surgical treatment, Sepsis-Related Organ Failure Assessment score, and peritonitis from colonic perforation. We performed a multivariate analysis that included the predictive factors with significant links with mortality in the univariate analysis; odds ratios were estimated using an unconditional logistic regression model. Statistical significance was defined as $P<.05$. All analyses were performed using SAS computer software (SAS Institute Inc, Cary, NC).

RESULTS

Ischemic colitis was diagnosed in 49 patients (2.7%). There were 43 men and 6 women, with a median age of 71 years (age range, 46-81 years). All but 2 patients had underlying atherosclerosis disease, and 6 patients had diabetes mellitus. The 2 patients without atherosclerosis (aged 46 and 54 years) had Marfan syndrome.

Ischemic colitis occurred in 16 (2.0%) of 815 patients who were electively treated for an abdominal aortic aneurysm (all after conventional surgery) vs 0 of 324 patients who underwent endovascular procedures ($P<.001$). However, endovascular treatment in 2 patients was converted to open surgery during the procedure because of technical failures, and they were included in the conventional surgery group. The incidence of IC was similar among patients with thoracoabdominal aortic aneurysm (9/442 [2.1%]) and among patients with aortoiliac occlusive disease (3/364 [0.8%]). It was higher among patients with in situ aortic allograft replacement (5/75 [6.7%]) and among patients who underwent urgent surgery for a ruptured abdominal aortic aneurysm (16/90 [17.8%]).

The median duration between aortic surgery and suspected IC was 1 day (range, 0-15 days). Colonoscopy was performed in 36 patients (73.5%), including 8 patients (22.2%) who underwent more than 1 endoscopy. The procedure was nonconclusive in 5 patients (13.9%) and showed various degrees of IC in the others (6 patients with type 1 [16.7%], 12 patients with type 2 [33.3%], and 13 patients with type 3 [36.1%]). Fifteen patients (30.6%) underwent a computed tomographic scan, the results of which were interpreted as normal in 8 patients (53.3%) and which was the only contributive procedure for diagnosis in 4 patients (including 1 patient who had nonconclusive endoscopic results and 3 others who did not undergo an endoscopy).

On initial evaluation, immediate surgery was opted for in 24 patients (49.0%), including 15 patients with final IC type 3 with MOF, 5 patients with final IC type 2 with MOF, and 4 patients with final IC type 3 without MOF. Of 25 patients without MOF and with transient or undetermined endoscopic findings on initial evaluation (6 patients with type 1, 7 patients with type 2, and 12 patients with undetermined IC type), 19 (76.0%) underwent surgery after a median delay of 1 day (range, 0.8-11 days) for

Table 1. Progression of Ischemic Colitis (IC) Following Aortic Reconstruction Among 49 Patients

Initial IC Type and Patient Group	Immediate Surgery		Secondary Surgery: Yes		Secondary Surgery: No	
	No. of Patients	Final IC Type	No. of Patients	Final IC Type	No. of Patients	Final IC Type
With colonoscopy (n = 36)						
1 (n = 6)	0	. . .	2	2 (2 Patients with MOF)	4	1 (3 Patients without MOF) 2 (1 Patient without MOF)
2 (n = 12)	5	2 (5 Patients with MOF)	5	2 (1 Patient with MOF) 3 (3 Patients with MOF and 1 patient without MOF)	2	2 (2 Patients without MOF)
3 (n = 13)	13	3 (9 Patients with MOF and 4 patients without MOF)	0	. . .	0	. . .
ND (n = 5)	0	. . .	5	3 (5 Patients with MOF)	0	. . .
Without colonoscopy (n = 13)						
ND (n = 13)	6	3 (6 Patients with MOF)	7	3 (7 Patients with MOF)	0	. . .
Total	**24**	. . .	**19**	. . .	**6**	. . .

Abbreviations: MOF, multiple organ failure; ND, not determined; ellipses, not applicable.

Table 2. Characteristics of 43 Patients Who Underwent Colorectal Resection for Ischemic Colitis (IC) Following Aortic Reconstruction

Characteristic	No. (%) of Patients
IC location	
Rectum	23 (53.5)
Left colon	42 (97.7)
Transverse colon	26 (60.5)
Right colon	22 (51.2)
Surgical procedure	
Sigmoid resection with end colostomy	1 (2.3)
Left colectomy with end colostomy*	20 (46.5)
Right colectomy with end colostomy	1 (2.3)
Total colectomy with end ileostomy†	21 (48.8)
Associated cholecystectomy‡	30 (69.8)

*Includes 7 patients who also underwent transverse colonic resection.
†Four patients had completion total colectomy for ischemic extension after left colonic resection, after a median delay of 2 days (range, 2-6 days).
‡Five patients had previous cholecystectomy. Three of 8 patients who had no associated cholecystectomy developed acalculous acute cholecystitis during the postoperative course.

progression to final IC type 3 (16 patients, including 15 with secondary MOF) or to final IC type 2 with MOF (3 patients). Therefore, the final degree of ischemia as determined by endoscopy or surgery was 3 patients (6.1%) with final IC type 1, 11 patients (22.4%) with final IC type 2, and 35 patients (71.4%) with final IC type 3 (**Table 1**).

Six patients (3 patients with final IC type 1 and 3 patients with final IC type 2) received nonoperative IC management. The remaining 43 patients (87.8%) underwent surgery. The locations of colonic ischemia and the surgical procedures are summarized in **Table 2**. One or more postoperative complications occurred in 26 (60.5%) of 43 patients, including 19 patients (44.2%) who required reoperation for completion total colectomy (n=4), rectal stump (n=5) or fistula of the small bowel (n=2), intra-abdominal bleeding (n=3) or abscess (n=5), acalculous acute cholecystitis (n=3), and wound abscess (n=1).

The overall mortality was 46.9% (23/49). The mortality was 57.1% (20/35) for patients with final IC type 3, 37.5% (3/8) for patients with final IC type 2 with MOF, and 0% (0/6) for the patients with final IC type 1 or with final IC type 2 without MOF. Fifty-four percent of patients (23 of 43) died after colorectal resection. Univariate analysis revealed several factors causing significant risk of death, including MOF, final IC type, need for colonic resection, and amount of perioperative red blood cell transfusion (**Table 3**). Sex, age, initial IC type, need for reoperation, extent of colectomy, primary aortic disease, and peritonitis from colonic perforation at surgery were not significant factors (Table 3 and **Table 4**). In the multivariate analysis, the amount of perioperative red blood cell transfusion remained the only factor that was significantly associated with postoperative death (odds ratio, 3.9 [95% confidence interval, 1.0-16.0]). Four (20.0%) of 20 long-term survivors died of unrelated conditions (myocardial infarction, intestinal infarction, respiratory failure, and lung carcinoma) during follow-up. Nine (56.3%) of 16 long-term survivors underwent stoma closure after a median time of 6.5 months (range, 6-10 months).

COMMENT

This study presents a logical approach to controversial issues encountered in the diagnosis and management of IC following aortic reconstruction. Our recommendation is to guide the surgical approach based not only on the type of endoscopy but also on the consequences of colonic ischemia on vital organs; in patients with apparent nontransmural colonic ischemia with MOF (type 1 and type 2), surgical resection of the colon should be performed urgently.

Previous studies[1,9] have shown that the incidence of IC may be underestimated in patients operated on for thoracoabdominal aortic reconstructions if colonoscopy is not performed in the event of postoperative complications. In

Table 3. Factors Predicting Death Among 49 Patients With Ischemic Colitis (IC) Following Aortic Replacement

Factor	Dead (n = 23)	Alive (n = 26)	*P* Value
Male-female ratio	20:3	23:3	.87
Age, mean ± SD, y	69.1 ± 9.3	69.2 ± 5.9	.97
Primary aortic disease			.08
Abdominal aortic aneurysm (n = 32)	12	20	
Thoracoabdominal aortic aneurysm (n = 9)	4	5	
Aortoiliac occlusive disease (n = 3)	3	0	
In situ aortic allograft replacement (n = 5)	4	1	
Perioperative red blood cell transfusion, U*			<.01
≤8.5	7	17	
>8.5	16	7	
Initial IC type†			.22
1 (n = 6)	1	5	
2 (n = 12)	6	6	
3 (n = 19)	7	12	
Not determined (n = 12)	9	3	
Final IC type†			.02
1 (n = 3)	0	3	
2 (n = 11)	3	8	
3 (n = 35)	20	15	
Multiple organ failure			<.01
Yes (n = 38)	22	16	
No (n = 11)	1	10	
Sepsis-Related Organ Failure Assessment score, mean ± SD	10.7 ± 4.2	9.0 ± 4.0	.19
Need for colonic resection			.02
Yes (n = 43)	23	20	
No (n = 6)	0	6	

*Median, 8.5 U; unknown in 2 patients.
†Types of IC were derived from results of colonoscopy or surgery, when performed.

Table 4. Surgical Factors Associated With Death Among 43 Patients Who Underwent Colorectal Resection for Ischemic Colitis (IC) Following Aortic Reconstruction

Factor	Dead (n = 23)	Alive (n = 20)	*P* Value
Peritonitis from colonic perforation			.88
Yes (n = 7)	3	4	
No (n = 36)	20	16	
Total colectomy			.28
Yes (n = 21)	13	8	
No (n = 22)	10	12	
Need for reoperation			.47
Yes (n = 19)	9	10	
No (n = 24)	14	10	

patients with surgical repair of a ruptured abdominal aortic aneurysm, it has been recommended that a colonoscopy be performed systematically within 48 hours of completion of the repair, regardless of clinical findings.[10] However, misdiagnosis of transient IC may not be of clinical relevance in the absence of warning signs or organ failure. In fact, severe IC is more easily identified given that it produces direct or indirect warning symptoms prompting the surgeon to perform a colonoscopy. Our 2.7% incidence rate reflects clinically expressed IC, is within the range of previously reported rates,[3] and correlates with the technique used for aortic repair. Ischemic colitis was never observed after endovascular procedures and was more frequent after surgery for aortic aneurysm than for aortoiliac occlusive disease, although the difference did not reach statistical significance ($P=.15$). The absence of IC after endovascular aneurysm repair is in accord with results of a recent study[11] and might be explained by the fact that the endovascular insertion of an aortic prosthesis avoids open surgical handling of the colon, which may impair mucosal barrier function and induce portal endotoxemia.[12] Therefore, endovascular procedures could protect against IC risk.

To date, surgery remains the predominant technique for treating aortic aneurysms; therefore, early and accurate diagnosis of IC remains a critical challenge. In accord with findings from previous studies,[1,9] our data show that diagnosis remains difficult, despite a vigilant detection policy; endoscopy, which remains the reference diagnostic tool, was performed in 73.5% of our patients but cannot be performed in every patient, sometimes provides nonconclusive results (13.9% in our series), and cannot always delineate between transmural necrosis and mild ischemia.[13] Helical computed tomography has many limitations[14] and cannot be considered a reliable alternative.

In patients without MOF, if transient IC is diagnosed by colonoscopy, conservative management is recommended. As observed in 19 of our 25 patients initially managed nonoperatively, secondary worsening of IC requiring surgery is possible.[15] This possible aggravation, together with the limitations of IC diagnostic procedures, justifies the careful monitoring of patients with IC in the intensive care unit. The benefits of active resuscitation in the intensive care unit may paradoxically contribute to a delay in the necessary surgery. In the present study, the delay between the onset of symptoms and colon surgery was as long as 11 days for some of our patients who were initially managed nonoperatively.

During surgery, the extent of IC is difficult to assess. None of the techniques reported to be of interest in this evaluation have proved their usefulness in clinical practice.[16] Like others,[17] we believe that the main goal is to resect the entire ischemic bowel rather than to preserve a minimal length of colon. As a consequence, we based the assessment of the extent of IC on operative examination and palpation, although these methods have provided misleading results.[18] In the case of partial colonic resection, examining the margins of the resected colon can help determine the choice between limited or extensive colectomy. If the margins are involved, colonic resection should be extended. In addition, a prophylactic cholecystectomy should be performed because acute acalculous cholecystitis and IC share the same pathophysiology of arteriolar microthrombosis and mural lesions. If cholecystectomy is not performed during colonic resection, the patient is at risk of acute postoperative acalculous cholecystitis, requiring repeat surgery. After this complication was observed in 3 of our early patients, we recommended prophylactic cholecystectomy in all patients operated on for IC following aortic reconstruction.

Reported IC mortality varies among series. Conclusions are limited because of failure to differentiate

between IC and acute intestinal ischemia and because of small numbers of patients with IC. In small series (7-32 patients with colonic resection),[1,2,19] the overall IC mortality ranges from 57% to 67%, with type 3 proving to be particularly severe, with a mortality ranging from 76%[19] to 89%.[2] In our series, mortality was 53.5% after colonic resection. While prompt diagnosis and aggressive management are usually considered major factors in improving the outcome for patients with IC,[20] the role of surgery is still controversial. Surgery is no longer considered for type 3, even without MOF,[2,19] but the approach for type 2 with MOF is subject to debate. Most studies[1,20-23] recommend surgery in the case of a nonspecified combination of severe ischemia and clinical symptoms. However, the indications for urgent colonic resection are rarely specified,[2,9,19] even though the severity of this complication is life threatening. Based on clinical experience, we recommend that surgery be performed urgently in patients with type 2 with MOF. In the present study, this approach resulted in a global mortality of 27.3% (3/11) for patients with type 2 and a postoperative mortality of 37.5% (3/8) for patients with type 2 with MOF who underwent colorectal resection, compared with previously reported rates ranging from 60% to 80%.[2,18,19,24] This aggressive approach had a high morbidity rate, with nearly half of the patients needing reoperation. However, this morbidity did not affect mortality. Because most patients with type 2 underwent surgery, it is legitimate to consider whether immediate surgery should be recommended for all patients with type 2. Our results showed that 3 (42.9%) of 7 patients without MOF who were categorized as having final IC type 1 or 2 at their final endoscopy were cured without surgery. We believe that avoiding surgery in these patients is important because urgent colectomy is not a benign procedure. Therefore, we cannot recommend that all patients with type 2 should undergo immediate surgery, although discussion remains open for patients without MOF.

This study has some limitations, mainly related to its retrospective nature. However, a prospective study comparing emergency surgery with nonoperative management for patients with MOF and IC seems to be infeasible because results from previous studies[1,20-23] point strongly toward the suggestion that nonoperative management would be unethical. Another limitation is that the endoscopic method of assessing colonic ischemia is subject to sampling errors. Because almost all IC following aortic reconstruction involves the sigmoid colon, one can reasonably assume that the appearance of the sigmoid colon is a good indication of IC. However, there is no evidence suggesting that the type of ischemia is the same all along the affected colon. Therefore, because endoscopic examination was stopped at the first sign of ischemia in our series, a more severe area of ischemia may have been overlooked at the first examination. This may have accounted for the misclassification of several patients who went on to require surgical exploration because of a progression to transmural ischemia. Despite these limitations, our study suggests that an aggressive approach is mandatory not only in transmural gangrene but also in transient forms when associated with MOF.

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