Mesenteric Vascular Disease

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Mesenteric vascular occlusion and intestinal infarction remain an unsolved problem. Among 136 patients with acute mesenteric infarction reported by Ottinger and Austen [1] from the Massachusetts General Hospital, only 8 per cent survived, dramatically demonstrating the need for improvement in diagnosis and treatment of this condition. These patients represented almost 1 in every 1,000 hospital admissions, indicating that the disease was fairly common as well as serious.

At The Johns Hopkins Hospital from 1963 to 1970, thirty-three patients had the diagnosis of acute mesenteric infarction confirmed at operation or autopsy. (Table I.) Patients with infarction caused by strangulation were excluded. Among the thirty-three patients, five survived and these five were among the twenty-five who underwent operation.

Improvements in these results may be obtained by a consideration of therapy in relation to the pathologic findings, excluding the rare cases of infarction caused by arteritis or dissecting aneurysms. Important therapeutic decisions must be made within a few hours after the onset of abdominal pain if optimal treatment is to be given. (Table II.) If more than approximately twelve hours elapse, the only procedure likely to be available is extensive intestinal resection from which few patients survive. At The Johns Hopkins, in twelve patients requiring resection of more than half the small intestine and ascending colon, the mortality was 100 per cent.

In the first few hours after the onset of abdominal pain that may be caused by mesenteric vascular disease, it is critical not to overlook an embolus. Nearly all of the patients who survive vascular reconstructive operations for acute mesenteric vascular disease are those who can be successfully treated by embolectomy [2]. Often such patients have normal mesenteric vasculature and an underlying cardiac condition that can be corrected subsequently. The experimental studies of Glotzer and colleagues [3] clearly show that the canine intestine can withstand up to six hours of ischemia and still recover completely, but after eight hours of ischemia, all dogs die of intestinal gangrene. The period of time for making a correct diagnosis and carrying out surgical treatment is critically short.

A high level of suspicion is the first requirement for a correct diagnosis of mesenteric embolus. Minimal evidence must be accepted as cause for action if the diagnosis is suggested by acute midabdominal pain in a patient with previous or concurrent embolizations or atrial fibrillation from either arteriosclerotic or rheumatic origin. The only symptom seen invariably is abdominal pain. Other findings such as diarrhea, tenesmus, bloody stools, absence of gas on abdominal x-ray films, elevated serum amylase levels, or leukocytosis add to the picture, but their absence does not rule out the diagnosis. In a patient who has sudden onset of abdominal pain and a propensity for embolism, arteriography should be performed as quickly as possible. Only by this technic will the diagnosis of embolism be established early enough for embolectomy to be performed. The modern radiology department should routinely be capable of providing technically satisfactory radiographic visualization of the mesenteric vasculature within two hours or less.

TABLE I Mesenteric Infarction:
The Johns Hopkins Hospital (1963–1970)

Procedure	Number of Patients	Number of Deaths	Mortality (%)
No operation	8	8	100
Laparotomy only	6	6	100
Embolectomy	2	0	0
Arterial graft	1	1	100
Segmental resection of intestine	4	1	25
Resection of small bowel and ascending colon	12	12	100
Total	33	28	85

Case Reports

Case I. A forty-seven year old woman admitted to the hospital because of femoral embolus had sudden acute abdominal pain approximately one week after admission. When examined shortly thereafter, bowel sounds were present, the abdomen was nontender, the white blood cell count was slightly elevated, and the abdominal x-ray film showed a nonspecific gas pattern. The over-all clinical impression was not one of an abdominal catastrophe. However, because of the combination of acute pain and previous embolization, mesenteric angiography was promptly performed and demonstrated an embolus of the superior mesenteric artery. Surgery was performed within six hours of the onset of pain. Successful embolectomy was accomplished, intestinal viability was restored, and the patient recovered promptly.

Comment: Waiting for any of the other signs of mesenteric infarction would undoubtedly have resulted in gangrene of the intestine and a much less favorable opportunity for a successful outcome.

TABLE II Acute Mesenteric Vascular Disease

	Therapy		
Pathology	Within Twelve Hours	After Twelve Hours	Late
Superior mesenteric artery embolus	Embolectomy	Resection	? Cardiac surgery
Atherosclerosis			
Nonocclusive	Supportive	? Resection	Bypass
Occlusive	Bypass	Resection	
Venous thrombosis	Heparin	Resection	
Inferior mesenteric artery occlusion	Supportive	? Resection	

Case II. A fifty-three year old man had acute abdominal pain after cardioversion for atrial fibrillation. Initially, abdominal tenderness was minimal, the white blood cell count and amylase levels were within normal limits, and an abdominal x-ray film showed a nonspecific pattern with only a small amount of gas in the large intestine. Surgical consultation was not obtained until seventy-two hours later when there were clear-cut physical findings of peritonitis and extensive dilatation of the large and small intestine on abdominal x-ray examination. Laparotomy without angiography was performed promptly. At operation, an embolus was removed from the superior mesenteric artery, and backbleeding was obtained from the right colic artery distal to the site of lodgment of the embolus. Backbleeding was not obtained from the small bowel vessels. Nearly all of the small intestine and ascending colon to the hepatic flexure appeared nonviable, but there was no frank gangrene or perforation. Since backbleeding was obtained from the right colic artery, the abdomen was closed and a second look operation was performed eighteen hours later in the hope that resection of the ascending colon and terminal ileum might be avoided. At reoperation the distal ileum and ascending colon had regained evidence of viability. Resection of the small intestine from 9 inches beyond the ligament of Treitz to 4 inches from the ileocecal valve was performed and end to end anastomosis successfully carried out. The patient survived, and with the ileocecal valve intact he was able to maintain a stable weight with approximately two to three bowel movements daily until he died of the underlying cardiac disease approximately fifteen months later.

Comment: Embolectomy performed in the presence of apparently irreversible intestinal ischemia resulted in salvage of a critical portion of the intestine and increased the patient's chances for subsequent recovery. However, if the correct diagnosis had been made promptly, all intestinal resection might have been avoided.

Comments

Successful embolectomy is reported as late as ten days after the event with restoration of intestinal viability under unusual circumstances [4]. In situations in which viability of the intestine after vascular reconstruction is not certain, the second look operation twelve to twenty-four hours later may be essential [5]. Clearly, when necrotic intestine is encountered, it should be resected at the initial operation. When definite viability is restored by the vascular operation, a second look procedure is not necessary. The major problem that led to the development of the second look concept was the inability of the surgeon to deter-

mine whether the intestine was viable after the blood supply had been restored. It is well known that the return of arterial pulsations and color to the intestinal wall is not an accurate guide to the viability of the intestine. Since the second look operation imposes a substantial added risk for the patient, a more precise method than observation of pulses and color is needed to detect intestinal viability at the time blood flow is restored.

Bussemaker and Lindeman [6] reported that muscle activity measured by electromyography was an accurate guide in predicting viability of intestine after revascularization. They noted that an increased temperature of 1°C in a segment of bowel that had been revascularized compared with the temperature in adjacent normal bowel exposed to air indicated that the intestine would survive. Segments of bowel that did not show an increased temperature became gangrenous or fibrotic even though the outward appearance of the bowel suggested that viability had been restored. Although both methods offered improved accuracy over that of clinical evaluation, technical problems in recording electromyograms and calibrating and measuring temperature with thermistor probes in the operating room raised doubts as to practicality of these methods in clinical practice.

Since the temperature changes observed by Bussemaker and Lindeman [6] reflected relative hyperemia of revascularized bowel compared with normal intestine, we thought that hyperemia might be measured in the operating room in a simple and reproducible way by using technics of nuclear medicine. In a series of experiments using the small intestine or colon of dogs or monkeys, increased concentrations of radioactive [99]Te-labeled albumin microspheres in revascularized intestine compared with normal bowel predicted viability with a high degree of accuracy after four to ten hours of ischemia [7–9].

For clinical application of this technic, a small hand-held counting probe is available for use in the operating room. The [99]Te-labeled microspheres are provided in most hospitals having nuclear medicine programs. Three to five microcuries are injected into the aorta at the level of the diaphragm. The intestine being revascularized and an adjacent segment of normal bowel are placed on a sterile lead sheet in the open abdominal incision and the relative concentrations of counts are compared between the segments. This simple method promises to resolve questions concerning intestinal viability and to eliminate the need for second look operations when ischemic intestine is encountered.

Given the urgency of early embolectomy if successful revascularization is to be performed, the question of the need to perform preoperative angiography may be raised. Why not explore all patients suspected of having a mesenteric infarction? The problem is that not all patients with symptoms suggesting mesenteric infarction will benefit from immediate laparotomy. A number of patients with mesenteric vascular disease have no major vessel occlusion amenable to reconstruction. Most of these patients have generalized atherosclerosis. In some, intestinal ischemia results from relative insufficiency of blood flow to the gut, usually because of low cardiac output. These patients are best treated by intensive cardiovascular supportive therapy rather than laparotomy in an attempt at reversal of the intestinal lesion if cardiac output can be improved.

Table III summarizes the clinical findings in four such patients in whom history, physical examination, and laboratory results strongly suggested mesenteric infarction and in whom early laparotomy was performed without angiography. No intestinal gangrene or vascular occlusion was found and no other source for the abdominal complaints other than relative intestinal ischemia was discovered. All four eventually died from complications of the operation and the underlying cardiovascular disease. Their best chance for survival would have been obtained by intensive medical therapy rather than early operation. The severity of pain in these patients and the abdominal and laboratory findings were indistinguishable from those seen in patients with embolism or thrombosis of the superior mesenteric artery. The only way to distinguish these patients with relative vascular insufficiency from those who have true occlusion has been the use of arteriography.

Accordingly, when patients with underlying atherosclerosis are suspected of having mesenteric vascular disease, intensive support should be instituted immediately and should include administration of digitalis, fluids to restore a normal central venous pressure, and isoproterenol if necessary. Intravenous heparin should be administered. While these measures are being taken, preparations for aortography should be made. If no major vessel occlusions are seen, operation is deferred while further intensive therapy is given. If the patient improves and abdominal signs subside, operation is not performed. If progressive worsening of the abdominal condition occurs, operation to resect gangrenous bowel can be performed a few hours later. If the patient recovers from an acute

TABLE III   **Acute Intestinal Angina without Occlusion or Infarction**

Age (yr) and Sex	Previous Disease	History	Physical Findings	Laboratory Data	Operation	Autopsy
72, M	Pneumonia, atherosclerosis	Abdominal pain 8 hr, guaiac-positive, diarrhea	Central venous pressure low, abdomen tender, peristalsis	White blood cell count 16,800 per mm³, amylase 38 gm/100 ml, hematocrit 51 per cent	Fluid, no disease, superior mesenteric artery pulse	18 days, cardiovascular accident, bowel normal, superior mesenteric artery open
80, M	Chronic congestive heart failure, lung disease	Abdominal pain 24 hr, vomiting, guaiac-positive, diarrhea	Central venous pressure low, abdomen tender, peristalsis active	White blood cell count 37,000 per mm³, amylase 12 gm/100 ml	Fluid, bowel injected, superior mesenteric artery pulse	5 days, pneumonia, bowel normal, superior mesenteric artery open
88, F	T₁₁ fracture, confusion, ? cardiovascular accident	Abdominal pain 4 days, vomiting, guaiac-positive	Abdomen tender, distended, and quiet	White blood cell count 16,000 per mm³, amylase 14 gm/100 ml	Fluid, no disease, superior mesenteric artery pulse	19 days, pulmonary embolus, bowel normal, superior mesenteric artery open
76, M	Angina, silicosis, hypertension	Abdominal pain 8 hr, guaiac-positive stool	Central venous pressure low, abdomen tender, peristalsis	White blood cell count 12,800 per mm³, amylase 12 gm/100 ml	No disease, ventricular fibrillation	Acute myocardial infarction, bowel normal, superior mesenteric artery open

episode and the aortogram shows evidence of narrowing of the mesenteric vessels, an elective bypass operation may be performed at a later date if there is evidence of intestinal angina or malabsorption.

Occasionally, an arteriogram will demonstrate an unusual vascular finding. Paloyan, Collins, and Washburn [10] recently reported on a patient in whom acute abdominal pain developed after meals and he was referred to The University of Chicago Hospitals as a case of acute mesenteric vascular occlusion. A bruit was heard over the abdomen. Prior to surgery, an aortogram demonstrated a large arteriovenous fistula which was the cause of the acute mesenteric angina. Preoperative demonstration of this fistula greatly facilitated surgical management.

If the aortogram shows superior mesenteric artery occlusion superimposed on atherosclerotic changes, early operation should be performed. An embolus may be encountered which can be removed or a bypass graft may be constructed from the aorta to the superior mesenteric artery beyond the site of thrombosis. Thromboendarterectomy does not give satisfactory results in the acutely infarcted intestine for several reasons including difficulty in controlling the origin of the atheroscle-

rotic vessel proximally, extent of the vessel narrowing, and difficulties in terminating the thromboendarterectomy distally. If operation is delayed until there is clear evidence of intestinal infarction, the chance to salvage bowel by vascular reconstruction is lost.

Venous thrombosis is less common than arterial occlusion. It usually occurs with underlying conditions such as cirrhosis and portal hypertension, pancreatic disease, and polycythemia vera. When venous thrombosis is suspected and no arterial occlusion is demonstrated by early angiography, heparin therapy should be given and surgery should be deferred until it is clear that infarction of the bowel has occurred. Resection should be performed promptly as soon as the need is demonstrated.

Inferior mesenteric artery occlusions with resulting ischemic colitis are rare and generally occur in patients with severe atherosclerosis involving not only the inferior mesenteric artery but also the superior mesenteric and celiac arteries. Marston et al [11] report sixteen patients with this diagnosis and observe three clinical patterns. In some, the lesion appears to be relative ischemia with reversal to normal colon when supportive therapy is given. In others, a stenotic segment de-

velops which can be resected electively. In a third group, the intestine becomes gangrenous and the segment is resected as soon as signs of peritonitis develop. The course that the ischemic bowel will follow can best be determined by intensive supportive therapy and close observation rather than by early operation, as successful reconstruction of the inferior mesenteric artery can rarely be anticipated.

Summary

In a patient with acute abdominal pain, the diagnosis of acute mesenteric vascular disease should be suspected immediately if there is a history of previous embolization, atrial fibrillation, or generalized atherosclerosis. Supportive therapy should be instituted promptly and should include treatment for congestive heart failure, hypotension, and dehydration. Heparin should be given intravenously to prevent extension of the occlusion. Angiography is essential in selecting those patients with superior mesenteric artery occlusion who should undergo immediate operation. At surgery, scanning of the revascularized intestine after aortic injection of ^{99}Te-labeled microspheres permits immediate determination of intestinal viability. If angiography demonstrates patency of the superior mesenteric artery, nonocclusive arteriosclerotic disease, venous thrombosis, or inferior mesenteric ischemic colitis is suspected and further supportive therapy and close observation are given. If abdominal findings progress to include peritonitis, laparotomy with intestinal resection is performed

in any of these groups. Patients found to have an embolus are carefully evaluated for later corrective cardiac surgery. Patients with extensive atherosclerosis who recover from an acute episode are considered for subsequent elective bypass to avoid future ischemic episodes. This program is clinically practical and offers the hope of greater salvage of patients with decreased operative risk in a disease that has thus far yielded poor clinical results.

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