

Arteriosclerotic Occlusion of the Superior Mesenteric Artery: *

Observations Concerning Surgical Treatment

ALLAN E. DUMONT, M.D., DAVID A. TICE, M.D.,
JOHN H. MULHOLLAND, M.D.

From the New York University School of Medicine, New York City

GENERALLY it is recognized that massive infarction of the small bowel in an arteriosclerotic patient results from gradual thrombotic obstruction of the superior mesenteric artery. Incomplete obstruction of this vessel causes symptoms only when circulatory demands exceed flow potential of the narrowed lumen and these symptoms may be little more than constipation and a preference for carbohydrates in the diet.^{3, 5} Activity of the intestinal tract determines the degree of oxygen extraction in the course of blood flow through the splanchnic bed. Marked changes in oxygen content of portal venous blood are related to intestinal activity and indicate a wide margin of safety. Intestine with diminished functional demands can be maintained viable despite markedly reduced flow rates. Not only are the clinical features of dangerously narrowed vessels obscure,^{1, 2} but diagnostic signs in patients with complete occlusion are also vague, and may lead to late operative treatment of unexpectedly advanced disease.

Most surgeons consider, when confronted with massive infarction in a precariously ill patient, that resection of the infarcted bowel is indicated. Success with this approach is achieved only occasionally.

Recently, evidence that complete thrombotic obstruction of the superior mesenteric artery may be relieved and bowel resection may be unnecessary, has appeared.^{4, 5} When bowel has already undergone the avascular changes loosely characterized by surgeons as irreversible, however, resection is considered mandatory.

That infarcted and discolored bowel may be viable was recognized by Welch, in 1887.⁷ Experiences with three patients who were operated upon after generalized peritonitis had been present for 24 hours or more bear this fact out. In each, appearance of the small bowel warranted the conclusion that hemorrhagic infarction had ensued many hours previously and by common criteria, the tissues were dead and resection was indicated. Following arteriotomy and removal of obstructing clot, however, pulsatile flow in the mesenteric vessels was restored and normal color and activity of the intestine returned. Although all three patients subsequently died, each survived long enough to demonstrate that apparently non-viable bowel can be revived when pulsatile flow is restored. Pertinent data are summarized in Table 1.

Case Reports

Case 1: A 56-year-old man was first seen in May 1955. He had complained of intermittent abdominal pain and severe constipation for several years. After a four-day exacerbation of these complaints, his symptoms cleared and he was treated for congestive heart failure. Four weeks later,

* Submitted for publication February 25, 1961.

Supported by grants from: U. S. Public Health Service A-2785 (C2); New York City, Department of Health, Health Research Council; and the New York Heart Association.

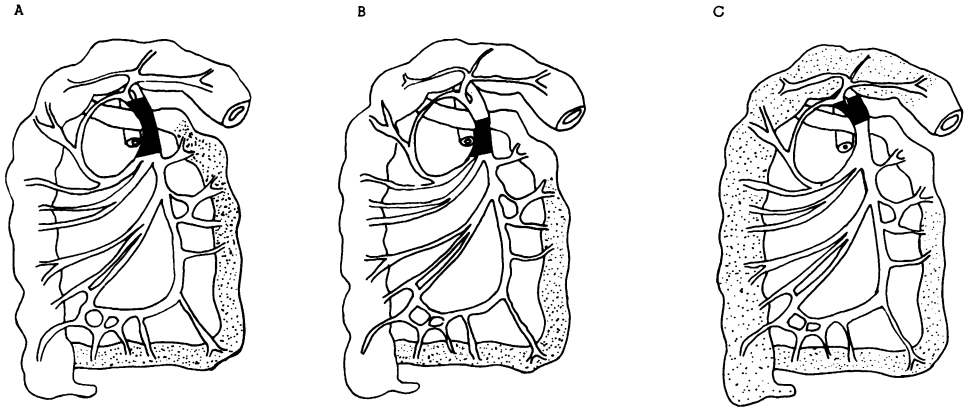


FIG. 1. A. Thrombotic occlusion of superior mesenteric artery distal to the origin of the middle colic artery with infarction of entire small intestine (Patient 1). B. Thrombotic occlusion of superior mesenteric artery distal to the origin of middle colic artery with infarction of entire small intestine (Patient 2). C. Thrombotic occlusion of superior mesenteric artery involving middle colic artery with infarction of most of the small intestine and proximal half of the large intestine (Patient 3).

while still in the hospital, the complaints re-appeared, at this time with bloody stools. Four days later it was recognized that he had generalized peritonitis and he was operated upon. A large amount of sero-fibrinous fluid escaped from the peritoneal cavity and the small bowel, from four inches distal to the ligament of Treitz to the ileocaecal junction was a mixture of shades of grey, purple, and black. There was no peristalsis and there were no pulsations in the mesenteric vessels. The superior mesenteric artery pulsated in

its first half inch (Fig. 1A). An incision was made in the artery at the point where pulsation ceased and a large partially organized clot was removed. Upon releasing the proximal tape and temporarily occluding the arteriotomy, pulsations returned in the distal arterial arcades and the color of the bowel immediately began to change except for 1½ inches of mid-jejunum which remained dark. Just before the final arteriotomy suture was placed, cardiac arrest occurred. Despite massage of the heart and other resuscitative measures, spontaneous

TABLE 1. Summary of Pertinent Data from Three Patients

Age Sex	56 Male	58 Male	65 Male
Previous history	"Chronic GB Disease"	Chronic upper intestinal symptoms operated at another hospital 4 weeks PTA	"Chronic GB Disease"
Duration present (symptoms to time of operation)	96 hours	44 hours	24 hours
Involvement of intestine	4" from lig. Treitz to cecum	lig. of Treitz to cecum	12" from lig. Treitz to transverse colon
Operation	SMA Endarterectomy, embolectomy and irrigation	SMA Embolectomy and endarterectomy	SMA Embolectomy
Result	Return to normal color except for 1½" of mid-jejunum	Return to normal color. Reoperation 5 days later	Return to normal color of all involved intestine
Complicating diseases	ASHD CHF. Cardiac arrest	Signs of CVA on 10 postop. day	ASHD AF Myocardial failure and hypotension

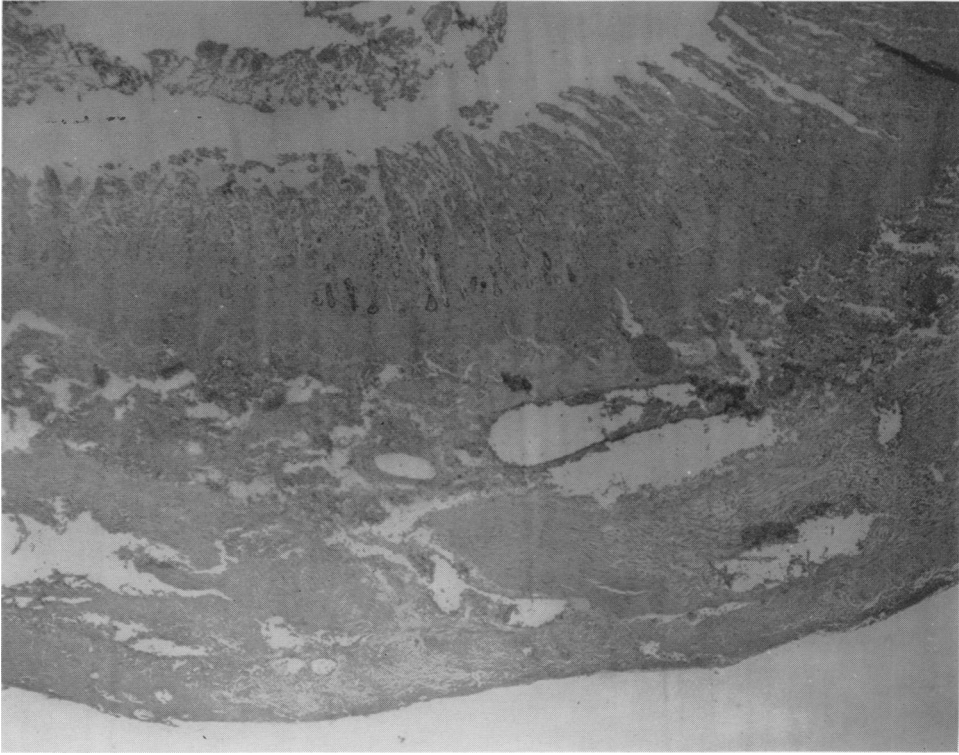


FIG. 2. Microscopic section of dog jejunum 30 hours following ligation of the superior mesenteric artery showing partial slough of the mucosal layer with intact submucosa and muscular layers.

activity did not resume. At autopsy there were pinpoint lumina in the major coronary vessels and extensive areas of old myocardial infarction. The aorta contained many sclerotic plaques with thrombi. The origin and course of the superior mesenteric artery were clear of thrombi except for some terminal branches adjacent to the bowel. The mesenteric veins were normal.

Case 2: A 58-year-old man was admitted in April 1958, because of generalized abdominal pain with nausea which began 36 hours before. Four weeks prior to admission, he had been operated upon at another hospital for similar though less severe complaints. Only a jejunal adhesion was found.

For the first 24 hours of the present admission, the patient was treated for mechanical obstruction of the small bowel with a long tube. At operation, approximately 44 hours after onset of symptoms, a large amount of foul smelling fluid was found in the peritoneal cavity and the small bowel was dull, greyish black, and without peristaltic activity. Pulsation in the superior mesenteric artery ceased just distal to the origin of the mid-colic artery

(Fig. 1B). After arteriotomy and removal of a large clot, pulsatile flow started. Color of the small bowel improved so that just prior to abdominal wound closure it was near normal. Bowel sounds were heard on the second day after operation and the patient was improving. Late on the fourth day he complained of sudden abdominal pain similar to that he had had before. Bloody diarrhea followed. At operation within a few hours a small amount of reddish fluid and patchy areas of discoloration in the small bowel were found. The superior mesenteric artery was reopened and fresh thrombus removed. Again the color of the bowel returned to normal. Once more he seemed to be making a satisfactory recovery when, four days later, he said that he could not see and he had a convulsion and died.

Case 3: A 65-year-old man was admitted in April 1958 for heart failure. Because of a history of vague gastro-intestinal symptoms, a cholecystogram was ordered. Before this could be done, he developed sudden crampy upper abdominal pain with vomiting. Twenty-four hours later he had generalized peritonitis. At operation, the small

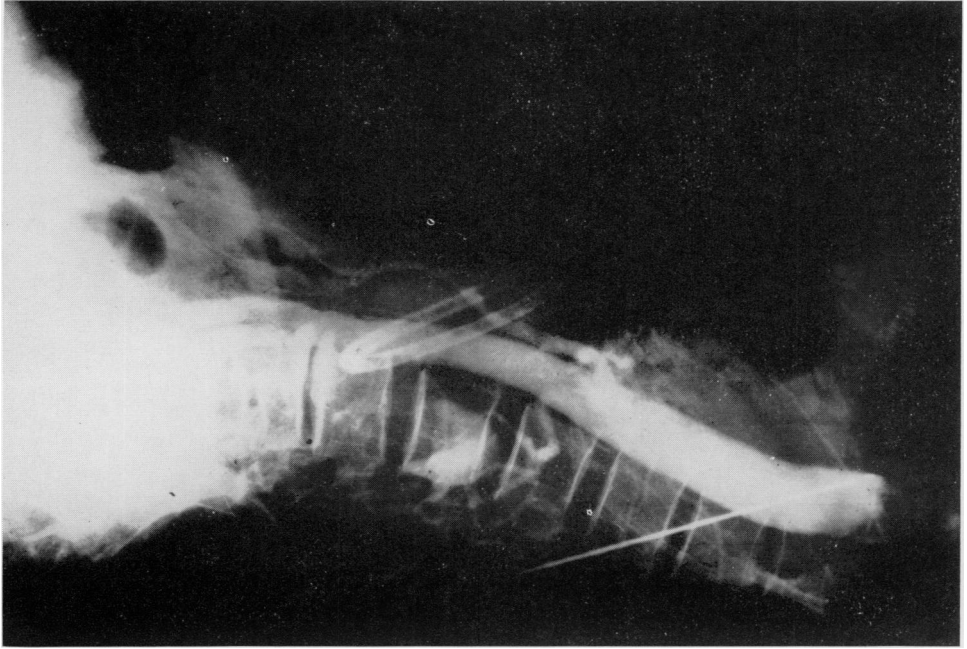


FIG. 3. Translumbar aortogram showing no visualization of either celiac artery or inferior mesenteric artery. Filling of superior mesenteric artery shows many large filling defects due to extensive arteriosclerosis.

bowel from 12 inches distal to the ligament of Treitz to the mid-transverse colon, was purplish black. The superior mesentery artery pulsated only in the first inch of its course (Fig. 1C). On opening the artery, there was a small amount of back bleeding and a large friable clot was removed. The bowel immediately became pink and pulsations resumed in all the mesenteric arcades. The post-operative course was marked by alternating types of abnormal cardiac rhythms and heart failure. He died in 36 hours.

Discussion

Hemorrhagic infarction of the small bowel produces discoloration and loss of sheen. Red blood cells escape through altered capillaries into interstitial and lymphatic spaces, lose oxygen, and become dark in color. Microscopically, mucosa suffers most with the passage of time. Figure 2 is a section of dog jejunum removed 30 hours following superior mesenteric artery ligation. It is evident that although a partial slough of mucous membrane has occurred, the remaining layers of the bowel appear hemorrhagic but intact.

Describing his extensive studies on the effects of superior mesenteric artery ligation in dogs, Welch stated:

"Immediately after ligating the superior mesenteric artery the muscular walls of the intestine contract and become anaemic. This condition continues for some three to four hours, when the intestinal walls gradually relax and the mucous membrane becomes first hyperaemic and then infarcted, the process extending from the middle of the duodenum downward. The infarction is complete at the end of six to eight hours; after this time its intensity is not generally increased as the excess of blood now leaves the tissues and enters the lumen of the intestine. The various experiments upon which the above statements are made are given in Table 2. After the infarction is complete, the muscular walls of the intestine gradually become flabby, the process beginning in the duodenum, then gradually extending to the caecum. The intestine dilates, putrefaction takes place within the lumen and gas is formed which gradually distends the walls and discolors the hemorrhagic mucous membrane. Even in extreme states of relaxation, the muscular walls are not necessarily dead."⁷

It is clear from Welch's description and from the clinical observations reported here that these changes are reversible. Welch also observed the presence of red cells in lymphatics shortly after ligation of the superior mesenteric artery. Altered capillary permeability permits egress of cells into the lymphatic spaces. Under these circumstances perhaps altered tissue protein or bacterial endotoxin also gain access to the general circulation along a lymphatic route. Investigations along these lines are in progress.

Even though massive small bowel resection might be avoided by restoration of pulsatile flow, superior mesenteric artery exploration in desperately ill patients is not without difficulty and risk. Arteriosclerotic patients with vague abdominal complaints, peculiar dietary habits, constipation, and bouts of distention might well benefit from x-ray studies of major visceral arteries by aortography. Surgical removal of obstruc-

tive arterial lesions before complete occlusion is rational and feasible.⁶ Information available through aortography is illustrated in Figure 3. This 70-year-old patient underwent limited small bowel resection for superior mesenteric artery occlusion. Abdominal pain, fever, and distention persisted. Lumbar aortography showed partial obstruction of the superior mesenteric artery with no visualization of either celiac or inferior mesenteric arteries. At autopsy two days later, an atheromatous plaque was found almost completely filling the lumen of the superior mesenteric artery and the other two vessels were completely obliterated.

Summary

Observations made in three patients operated upon for mesenteric artery occlusion suggest that

1. In the weeks or years before complete thrombotic obstruction of the superior mesenteric artery, intermittent symptoms may

TABLE 2. *Summary of Clinical Observations from Studies of Welch on Superior Mesenteric Artery Ligation in Dogs*

Experiment	Duration of Experiment (hrs.)	Condition of the Intestine	Remarks
1	3	Muscle walls pale, mucosa hyperemic	
2	4	Somewhat more hyperemic than No. 1	
3	5	Hyperemia of mucosa, more intense than No. 2	
4	5	Mucosa of parts supplied by the artery hyperemic	The artery ligated was one of the large branches of the superior mesenteric
5	5	Infarction of the entire mucosa	
6	6	Infarction of the entire mucosa	
7	7	Infarction of the entire mucosa	
8	7	Infarction more intense than No. 7	
9	12	Complete infarction of the intestine	There was much blood within the lumen of the intestine
10	21	Cat. The infarction is mottled but not complete	Considerable blood within the lymphatic channels
11	18	Intestine dilated and flabby; mucosa very hemorrhagic	Intestine filled with gas and blood

be attributable to inability of the reduced lumen to deliver blood for extra demands.

2. Operative removal of a thrombus obstructing the superior mesenteric artery may restore circulation and reverse color changes which appear to be long-standing and lethal.

3. In considering whether or not to remove obstructing clot in this vessel or to resect infarcted bowel, surgeons be guided by a principle well expressed in a statement of Thomas G. Orr: "We now doubt our ability to draw a sharp line between viable and nonviable intestine based upon its appearance unless frank necrosis with slough has developed."⁴

Bibliography

1. Dunphy, J. E.: Abdominal Pain of Vascular Origin. *Am. J. of Med. Sc.*, **192**:109, 1936.
2. Klass, A.: Intestinal Angina and Infarction. *Canad. M. A. J.*, **82**:620, 1960.
3. Mulholland, J. H.: Early Attack on Severe Disease. *Amer. Surg.*, **26**:634, 1960.
4. Orr, T., *et al.*: Mesenteric Vascular Occlusion, a Report of Two Cases. *J. A. M. A.*, **155**:648, 1954.
5. Shaw, R. and E. P. Maynard, III: Acute and Chronic Thombosis of the Mesenteric Arteries Associated with Malabsorption. *New England J. of Med.*, **258**:874, 1958.
6. Shaw, R.: Vascular Lesions of the Gastrointestinal Tract. *Surg. Clin. of North America*, **39**:1253, 1959.
7. Welch, W. H.: *Collected Papers and Addresses*. Vol. I, 1920.

SURGICAL MEETING

The Southern Surgical Association will hold its Seventy-Third Annual Meeting at the Homestead, Hot Springs, West Virginia on December 5-7, 1961. Information may be obtained from the Secretary: J. D. Martin, M.D.

Department of Surgery
Emory University Hospital,
Atlanta, Georgia