

Critical Operative Management of Small Bowel Obstruction

RICHARD H. STEWARDSON, M.D.,* C. THOMAS BOMBECK, M.D., F.A.C.S.,† LLOYD M. NYHUS, M.D. F.A.C.S.‡

The records of 238 patients with the diagnosis of small bowel obstruction at the University of Illinois Hospital from 1967 through the spring of 1976 were reviewed. Mortality, intra-operative management, and clinical findings were evaluated. Previous reports list a mortality of gangrenous small bowel obstruction, secondary to hernia and/or adhesions, as >20%, although in this series, the mortality was 4.5% in patients with gangrenous small bowel obstruction. The present data reveal a 60% incidence of wound infection in patients in whom an enterotomy (iatrogenic, decompressive or resective) was made and the subcutaneous tissue and skin closed, and it is therefore recommended that the wound be left open in these situations. Although a variety of *individual* clinical findings have been advocated as diagnostic aids in patients with small bowel obstruction, this review suggests that attention to a *combination* of "classic" findings, *i.e.*, leukocytosis, fever, tachycardia and localized tenderness, portends a situation in which conservative observation is safe—namely, the absence of all four findings. The presence of any one or more of these findings mandates early operative intervention.

BASED ON THE REPORTS of several authors^{1,3,6,13,14,17,21,22,24} there are no reliably accurate criteria for determining, in the patient with signs and symptoms of small bowel obstruction, the presence of nonviable bowel within the abdominal cavity. Because strangulation obstruction carries a considerably higher mortality and morbidity than simple obstruction^{4,15,17,27} and in the belief that the complication rates could be decreased by earlier operative intervention and meticulous technique, we have surveyed our experience with small bowel obstruction for the period 1967–1976. The purpose of this study was threefold. 1) To determine the criteria for early operation vs. reasonable delay. 2) To determine the mortality rate of strangulation obstruction of the small bowel in a large teaching hospital whose clientele is largely the urban indigent. 3) To determine the factors increasing morbidity in terms of wound infection in the operative management of small bowel obstruction.

* Research Fellow and Instructor, Department of Surgery.

† Associate Professor of Surgery and Chief, Division of Surgical Gastroenterology.

‡ Warren H. Cole Professor and Head of the Department of Surgery.

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Reprint requests: C. T. Bombeck, M.D., Department of Surgery 840 South Wood Street, Chicago, Illinois 60612.

*From the Department of Surgery,
Abraham Lincoln School of Medicine,
University of Illinois College of Medicine,
Chicago, Illinois*

Materials and Methods

The records of all patients discharged from the University of Illinois Hospital from 1967 through the spring of 1976 with the diagnosis of small bowel obstruction, incarcerated hernia, volvulus, and intussusception were reviewed. Four hundred and thirty-five cases were studied. The diagnosis of complete small bowel obstruction was made according to the following criteria: history of abdominal pain, vomiting, and obstipation; clinical findings of abdominal distention and/or altered bowel sounds; and radiologic evidence of obstruction. Not all patients met all criteria, but all had radiologic evidence and either an admitting or a discharge diagnosis of small bowel obstruction. Patients with partial bowel obstruction, large bowel obstruction, incarcerated hernia which was reduced immediately upon admission followed by elective repair, mesenteric vascular occlusion, or an incomplete record were excluded. The remaining 238 cases form the basis of this report. Factors evaluated included the etiology of the obstruction; the preoperative diagnostic criteria present, including laboratory findings, temperature, pulse rate, and localized abdominal tenderness; the operative management and the postoperative course. Wound infection was defined as the presence of purulent material at the incision site.

Results

Etiology (Table 1)

Postoperative adhesions were the most common cause of obstruction (158 or 66%) in all patients. Forty-six patients (19%) who had had a previous abdominal operation and no history of neoplastic disease were presumed to have an adhesive bowel obstruction although they had no operation. The remaining 112 (47%) had the diagnosis of adhesive obstruction substantiated

TABLE 1. Etiology and Mortality in Small Bowel Obstruction

Etiology	# Pts	Deaths
Adhesions	152 (64%)	4 (3%)
Hernia	57 (24%)	1 (1.8%)
Malignancy	17 (7%)	7 (41.2%)
Volvulus	6 (3%)	1 (16.6%)
Intussusception	3 (1%)	0
Regional enteritis	3 (1%)	0
Total	238	13 (5.5%)

at operation. Hernias comprised 24% of the total; inguinal hernia was the most common type (54%). The remaining diagnoses included malignancy (7%), intussusception (1%), and regional enteritis (1%). There were six patients who had a primary volvulus; these were included in the category of adhesions unless otherwise specified.

Clinical Aids to Diagnosis

Classic findings associated with strangulation of the small intestine have long been regarded to be fever (temperature > 37.78° orally), tachycardia (pulse > 96 per minute), leukocytosis (WBC > 10,000 per mm³), and localized abdominal tenderness.^{5,14,20} The distribution of these findings in the patients with obstructing hernias are not included because the presence of an incarcerated hernia demands emergency operation regardless of the presence or absence of these "classic" findings.

There was no single finding of more value than any other in determining the presence or absence of gangrenous bowel. (Table 2). Of the 112 patients who had an operation, 71 (64%) had two or more of the classic findings. Seventeen patients (15%) had no findings but had an operation because of failure to resolve the obstruction non-operatively. Of the 23 patients who had gangrenous bowel, 20 (87%) had two or more of these classic findings. Forty-six patients had their obstruction resolved by non-operative measures and 44 of these (96%) had less than two findings. Most importantly, in the absence of all findings, no patient had gangrenous bowel.

An increase in serum amylase concentration has been suggested as a classic laboratory finding in patients with gangrenous bowel.^{4,14,20} In our series, serum amylase was not consistently measured, but in 12 patients in whom gangrenous bowel was later discovered, the serum amylase was elevated in only two. This finding is similar to the reports of others¹³ who found no consistent elevation of serum amylase in the presence of strangulated bowel.

Gangrenous Bowel (Tables 2 and 4)

Among the examined causes of small bowel obstruction, hernias were the most common, accounting for

37%; adhesions accounted for 21%. In the hernia groups, 75% of patients with femoral hernias had gangrenous bowel.

Complicating Factors

Wound infections. A total of 38 wound infections were encountered in the entire group; 29 (26%) of these occurred in the 112 patients operated upon for adhesive small bowel obstruction. Examination of these cases reveals that 28 of the 29 patients had an enterotomy performed for reasons listed in Table 3. The one patient who developed a wound infection but who did not have an enterotomy performed had the contents of a long segment of dilated bowel "milked" into the colon. In patients in whom the operative wound was primarily closed, wound infection developed in 75% (9/12) of the patients who had an enterotomy performed for decompression, in 64% (9/14) of the patients in which an iatrogenic or inadvertent enterotomy occurred, and in 46% (10/22) of patients requiring resection for gangrenous bowel. In other words, in those patients with adhesive small bowel obstructions in whom an enterotomy was performed or occurred, there was nearly a 60% occurrence of a postoperative wound infection if the entire wound was closed. None of the patients whose skin and subcutaneous tissue were left open to close secondarily or to be closed by delayed primary closure developed a wound infection.

In the patients who had gangrenous bowel secondary to a hernia, 50% (5/10) developed a wound infection when the entire wound was closed. Four of 16 patients (25%) with malignant obstruction requiring operation and an enterotomy developed a wound infection.

Mortality. In the 238 cases examined, there were 13 deaths (5.5%) occurring within 30 days of the diagnosis of small bowel obstruction. Seven of these deaths occurred in the group of 17 malignant obstructions, one of whom was a comatose, terminal patient whose

TABLE 2. Incidence of Classic Findings and Gangrenous Bowel in Adhesive Small Bowel Obstruction

	# Pts.	Gangrenous Bowel	Nongangrenous Bowel
Leukocytosis (WBC >10,000/mm ³)	55 (35%)*	20 (36%)†	36 (64%)†
Fever (>100°F or 37.78°C)	45 (28%)	16 (36%)	29 (64%)
Tachycardia (Pulse >96/min)	46 (29%)	16 (35%)	30 (65%)
Localized tenderness	52 (33%)	15 (29%)	37 (71%)
No findings	41 (26%)	0	41 (100%)
One finding	44 (28%)	3 (7%)	41 (93%)
Two findings	41 (26%)	10 (24%)	31 (76%)
Three findings	26 (16%)	6 (23%)	20 (77%)
Four findings	6 (4%)	4 (67%)	2 (33%)

* Per cent occurrence in total number of patients (158).

† Per cent occurrence in patients with each particular finding.

TABLE 3. Incidence of Wound Infection in Enterotomies for Adhesive Small Bowel Obstruction

Type of Enterotomy	#	Wound Closed	Wound Infection
Iatrogenic	15	14	9 (64%)
Decompressive	12	12	9 (75%)
Resection for gangrenous bowel	26	22	10 (46%)
Total	53	48	28 (58%)

family requested no operative intervention. Of the patients with adhesive obstruction, four died (3%). Three died of septic complications (two with adult respiratory distress syndrome and one other in septic shock) and one died of a pulmonary embolus.

There were only two patients with gangrenous bowel who died (4.5%); both patients had no operation. A premature infant died within 96 hours of birth with a respiratory distress syndrome complicated by suspected neonatal necrotizing enterocolitis. At post-mortem examination, he was found to have a primary volvulus of the distal ileum, gangrenous, perforated bowel and no evidence of enterocolitis. The other death was a 28-year-old woman, one year postvagotomy and pyloroplasty, who died with a suspected virulent left lower lobe pulmonary abscess, but who, at post-mortem examination, was found to have gangrenous small bowel and colon in a strangulated diaphragmatic hernia.

Discussion

The appropriate time to operate on the patient presenting with small bowel obstruction has plagued physicians for centuries.^{3,17,21} In an attempt to clinically identify the patient with nonviable bowel as early as possible, many authors have recommended a variety of physical findings and laboratory aids.¹⁴ All authors have noted inconsistency of these aids in selecting individual patients with strangulated bowel.^{14,15,22} All are in agreement, however, that after a period of observation, if the surgeon operates and finds dead bowel, he has delayed too long.

There is no correlation between the appearance of any one of the "classic" findings (e.g. leukocytosis, fever, tachycardia, localized tenderness) and the pres-

ence of strangulated bowel.^{3,5,13,14} This lack of correlation has been the basis for early operation in patients who present with small bowel obstruction. No report lists, however, the correlation of a combination of the findings with the presence of gangrenous bowel. Other investigators²⁰ in studies resembling the one described here, have also subdivided patients into groups with obstructions due to hernia and obstructions due to not readily apparent intra-abdominal causes. They have then attempted to apply the presence or absence of the four "classic" indications of dead bowel to both groups in deciding upon the need for urgent operation. We have regarded this as an error, since the mere presence of an incarcerated hernia, especially in the adult, is an indication for urgent operation. Indications of strangulation may change the operative approach somewhat (i.e. preperitoneal approach)¹⁸ but will not make the need for operation any more urgent than it already is.

We have examined four "classic" findings: leukocytosis (WBC > 10,000 per mm³), fever (temperature > 37.78° orally), tachycardia (pulse rate > 96 per minute) and localized tenderness. Length of history, muscle guarding, symptoms, and presence of a mass are all findings in which reliability and consistency among different physicians is difficult to ascertain. In our series, nearly 90% of the patients with gangrenous bowel exhibited two or more of these "classic" findings. No patient in the absence of all the classic findings had gangrenous bowel. Even though 96% of the patients with small bowel obstruction who did not require operation had one or none of these findings, three operated patients with only one finding were found to have gangrenous bowel. Therefore, we feel that until further data to the contrary is presented, there is reasonable safety in delay of operation and continued non-operative management in those patients admitted with small bowel obstruction who have neither leukocytosis, fever, tachycardia or localized tenderness. In the presence of any one finding, there is moderate safety in non-operative management especially in the poor risk patient. There was no significant difference between the incidence of gangrenous bowel in the group with one finding and the group with no findings. However, the incidence of gangrenous

TABLE 4. Incidence of Gangrenous Bowel, Wound Infection and Mortality in Hernias Causing Small Bowel Obstruction

Type	#	Gangrenous Bowel	Wound Closed	Wound Infection	Mortality
Inguinal	31 (54%)	10 (32%)	6	2 (33%)	0
Femoral	8 (14%)	6 (75%)	2	2 (100%)	0
Umbilical	9 (16%)	1 (11%)	0	0	0
Incisional	8 (14%)	3 (38%)	1	1 (100%)	0
Diaphragmatic	1 (2%)	1 (100%)	*	*	1 (100%)
Total	57	21 (37%)	10	5 (50%)	1 (1.8%)

* No operation performed.

bowel in the group with two findings versus the group with one finding was significantly greater ($p < .02$). If two or more findings are present, abdominal exploration must be carried out as urgently as the patient's condition will allow.

The pathophysiology of simple small bowel obstruction and strangulation obstruction has received considerable attention.^{1,13,17,21,27} As a result of concomitant advances in the understanding of bacteriologic aspects of obstruction, the introduction of newer antimicrobial agents, improved cardiorespiratory support, and improved nutritional support, especially hyperalimentation, the mortality of simple small bowel obstruction has decreased from 50% at the turn of the century²⁷ to a level of five to 10 per cent presently.^{4,15,21} However mortality from strangulation obstruction has not been improved to the same extent.²⁷ Mortality rates of 20–40% have been reported by many authors.^{3,14,15,19,22} Only one recent study reports a mortality of less than 10% from gangrenous bowel obstruction.²⁰

In our series, the mortality from nongangrenous small bowel obstruction was 5.6%. Excluding the patients with malignant obstruction, the mortality rate was 2.3%. The mortality rate for patients with gangrenous small bowel obstruction was 4.5%. The two patients with gangrenous bowel that died had erroneous diagnoses in which the obstruction was unrecognized and had no operation. No patient with either an incarcerated hernia or adhesive bowel obstruction and gangrenous bowel, who was operated upon, died. Barnett et al.³ predict a possible four per cent operative mortality for adhesive gangrenous bowel and a nine per cent operative mortality for herniated gangrenous bowel. On the basis of our review, we feel that these predicted mortalities may be too high and therefore unacceptable.

Little emphasis has been placed on the role of wound infection in the morbidity of small bowel obstruction. Yet the development of a postoperative wound infection generally doubles the length of the postoperative stay with a significant increase in hospital expense.⁹ Wound infection may lead to further complications such as wound dehiscence, or later, hernia formation.²⁵

The microflora of the intestine is in an intimate symbiotic relationship with man and is essential to life as a result of evolutionary adaptation.⁷ The normal flora of the small intestine includes a myriad of gram-negative and gram-positive organisms, both aerobic and anaerobic.^{8,11,26} Ever since the demonstration of *C. welchii* overgrowth in obstructed intestine with venous congestion,¹⁶ the pathophysiology of infectious complications of small bowel obstruction and gangrenous bowel obstruction has included the effect of an overgrowth or alteration of the normal microflora.^{10,17,26} In bowel

obstruction, venous congestion, edema, and subsequent restriction of arterial inflow lead to the breakdown of the barrier normally prohibiting access of the normal flora and their products to the general circulation. Exposing the operative field in any way to this altered, pathologic flora would predispose to an increased incidence of infectious problems.^{10,26}

Enterotomy for decompression of dilated bowel in an attempt to facilitate abdominal closure and enhance postoperative respiratory excursions has long been advocated.^{2,21,23} The resection necessary in the presence of gangrenous bowel is unavoidable. The inadvertent enterotomy in a difficult dissection is probably inexcusable² but seems to be always with us, especially when the surgeon is inexperienced. Avoidance of this technical mishap depends largely upon securing adequate exposure before intra-abdominal structures are divided. There is no substitute for meticulous technique. However, in the situation where an enterotomy is made, whether intentional (*i.e.*, decompression or resection) or inadvertent, spillage of contents of the obstructed intestine mandates therapy to combat the potential disaster.

Antibiotics may counter the effects of systemic introduction of infecting organisms. Instillation of antibiotic irrigations both intra-abdominally and locally at the wound site has been variably successful.^{2,4,13,21,23} Wound closure sets the stage for the development of a wound infection if the wound is contaminated with pathologic flora from the obstructed intestine. Although an open wound may become infected, the drainage, ease of irrigation and wound care, especially with prevention of spread of the infection, is facilitated greatly by the easy access to the depths of the wound. Our data support the suggestion that an enterotomy combined with wound closure predisposes to the development of a wound infection. Fifty per cent of patients with gangrenous bowel caused by an incarcerated hernia and whose wounds were closed developed a wound infection; the incidence in adhesive small bowel obstruction where an enterotomy was made was 58%. A similar incidence of wound infection (50%) was reported by Shatila et al.²⁰ We therefore suggest that intraoperative decompression be carried out via the nasogastric route and that decompressive enterotomy be avoided. In those situations where an enterotomy is unavoidable (whether for decompression or resection), it seems advisable that the subcutaneous tissue and skin should be left open and allowed to close secondarily or be closed by delayed primary closure.

Conclusions

When a patient presents with a small bowel obstruction and exhibits any one of the "classic" findings of

leukocytosis, fever, tachycardia, or localized tenderness, operative intervention and relief must not be delayed any longer than the time necessary to stabilize the patient. Reasonable safety exists in observation and non-operative management of those who have none of these findings. The mortality of gangrenous obstruction of the small intestine can approach a level of five per cent or less. If an enterotomy is made in the operative management of a small bowel obstruction, the subcutaneous tissue and skin should not be closed; the alternative is a greater than 50% chance of wound infection.

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