

ACUTE VOLVULUS OF SMALL INTESTINE

ANALYSIS OF 36 CASES*

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TORSION OF A LOOP of small bowel sufficient to produce intestinal obstruction and circulatory embarrassment of the involved intestine is one of the most serious intra-abdominal catastrophies. Fortunately this is an infrequent occurrence, but when it does take place, the necessity of recognizing its development and of instituting proper therapy cannot be emphasized too strongly. This condition is always associated with some degree of small bowel obstruction, the signs and symptoms of which frequently overshadow those of the volvulus itself, making early diagnosis difficult. The mortality rate associated with this catastrophe indicates its importance. Few conditions which develop within the abdominal cavity end fatally so frequently, due primarily to the difficulty in early diagnosis, since the surgical treatment after recognition is not particularly difficult. The chief problem is to differentiate between those causes of obstruction which demand early surgery and those which can be treated conservatively. If operations were performed more frequently in those patients in whom the presence of strangulated bowel cannot be ruled out, there would be fewer deaths from the more conservative treatment now in vogue.

The basis of this study is an analysis of 36 cases of volvulus of the small bowel occurring at Strong Memorial Hospital and Rochester Municipal Hospital between 1925 and June 1947.

INCIDENCE

Sweet¹ analyzed the 520 cases of acute intestinal obstruction exclusive of strangulated external herniae occurring at the Massachusetts General Hospital from 1873 to 1930 and found that volvulus of small and large bowel accounted for 53 of these, or 10 per cent. Of this number, 36 (67.9 per cent) involved small bowel, ten (18.8 per cent) involved the sigmoid and in six (11.3 per cent) the cecum was the offending site. Of a total of 148 cases of bowel obstruction reported by Skjold² there were only six instances of volvulus of the small and large intestine. Of the 261,024 patients seen in the Strong Memorial Hospital and Rochester Municipal Hospital between 1925 and June, 1947, there were 36 cases of volvulus of the small bowel, an incidence of one in approximately 7500 patients.

No age group is immune to this condition, the youngest in this series being two days old and the oldest, 79 years. Only five patients were under 20 years

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of age, however, while 11 patients were over 60 years of age. The average age was 45 years.

PATHOLOGY

The pathologic changes which take place in the loop of bowel involved in a volvulus depend largely upon the degree of embarrassment to the circulation to that loop. At the neck of the volvulus the afferent and efferent loops of bowel are twisted upon each other and upon the mesentery to the loop. The degree of obstruction to the blood supply, therefore, depends upon the tightness of the twist in addition to the number of twists.³ The venous return is blocked by lower pressure on the veins than is necessary to occlude the arterial blood supply. Therefore, with a fairly loose twisting at the base of the volvulus, venous engorgement of the involved loop may result without significant decrease in arterial blood supply. When the twists tighten by further torsion or by edema, the arterial blood supply is also impaired. Not infrequently the vessels may be thrombosed because of damage to their walls and to stasis.

There is always some degree of intestinal obstruction in addition to the circulatory changes in the loop of bowel. The obstruction is due to occlusion of the loop at the point of twisting. The dilatation of the volvulus is probably due to the gas-forming organisms trapped within the loop and to transudation of fluid. It represents a closed loop obstruction in itself. In some cases, the proximal loop may not be completely obstructed. In this situation one might expect a greater dilatation of the volvulus and perhaps an earlier rupture of the bowel wall.

In 27 patients, the obstruction was apparently complete or practically complete, while nine patients were only partially obstructed. The specific location of the volvulus in the small bowel was not recorded in eight cases. Among the other 28 patients, the ileum alone was the affected site in 24 (85.7 per cent); the jejunum alone in three (10.7 per cent), and both ileum and jejunum in one case (3.6 per cent).

Circulatory changes in the loops were present to varying degrees. Sixteen of these cases showed irreversible circulatory changes with gangrene of the bowel wall. In one of these there was gross perforation of the bowel. In nine patients there were marked circulatory changes, which showed improvement with release of the volvulus and therefore did not require resection. In the remaining 11 cases, the circulatory changes were either absent or present to only a very slight to moderate degree.

ETIOLOGY

Volvulus of the small bowel rarely occurs in an otherwise normal abdominal cavity. Usually there is some congenital or acquired abnormality which predisposes to this condition. Fixation of a part of the bowel by an adhesion, congenital band or other congenital anomaly, provides a point about which the small intestine may twist. Incomplete developmental rotation of the bowel may result in an unusually long mesentery, allowing abnormal mobility of a loop,

hence a greater chance to develop volvulus. Dott⁴ included volvulus in his discussion of the results of the arrest of development in any of the three stages of rotation of the intestines.

Our series contains several patients in whom the volvulus could be ascribed definitely to congenital malformation of the gastro-intestinal tract. One of them is of considerable interest and probably represents the youngest patient on record who survived resection of a perforated loop of intestine.

Case 1.—Baby boy C (261024) was born by hysterotomy in Strong Memorial Hospital on March 7, 1947, at 9:45 A.M. (Expected date of confinement March 29). The baby weighed 3070 Gm. at birth and appeared to be a normal healthy child. He took his feedings well and passed normal meconium per rectum shortly after delivery. On the morning of March 9 abdominal distention and lethargy were noted. No stools had been passed during the preceding day. Abdominal distention increased and the baby cried almost continuously.

Examination on the second day after birth revealed a small but well developed infant who appeared critically ill. The temperature was 37.8°C. (rectal) and blood leukocytes were 4600, of which 56 per cent were neutrophils. The abdomen was greatly distended and tympanitic. No peristaltic sounds could be heard. The liver dullness was obliterated. No masses could be felt in the abdomen. There was a soft mass in the left scrotum which was thought to be an indirect inguinal hernia containing a loop of bowel.

It was thought that the patient had intestinal obstruction, probably due to strangulated hernia with a perforation in the bowel at the point of strangulation. Roentgenogram of the abdomen revealed both free air and free fluid within the abdominal cavity (See Fig. 1).

Under ether anesthesia left rectus incision was made. A large amount of air escaped. There was much bile-stained fluid in the abdomen. The inguinal hernia had reduced itself prior to operation. The cecum lay in the right upper quadrant. There was a volvulus of 15 cm. of the ileum 12 cm. from the ileocecal valve. The intestine proximal to the volvulus was markedly dilated. The volvulus was twisted counterclockwise about 360° around a congenital fibrous band running from the liver down to the right lower quadrant. The involved loop appeared deep red at its base but was black and necrotic immediately adjacent to a hole in its midportion. The mesentery to the bowel involved in the volvulus was about one-third longer than the remaining mesentery. The congenital band was severed and the involved loop resected. End-to-end anastomosis was effected with 6-0

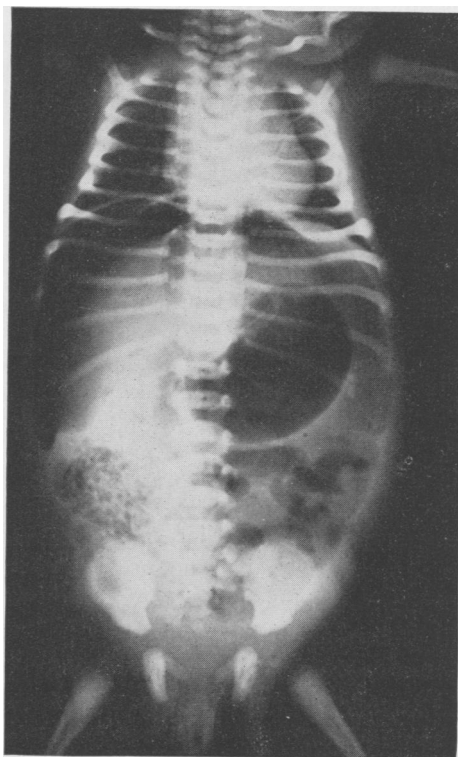


FIG. 1.—Roentgenogram of abdomen of 52-hour-old infant. A large amount of free air can be seen in the right upper quadrant extending to the left side between the liver and the diaphragm. Elsewhere there is a diffuse haziness denoting fluid within the peritoneal cavity.

silk. The patient's condition was extremely poor throughout the operation and remained critical for a week. He received continuous oxygen therapy, multiple blood transfusions, parenteral fluids and penicillin. His first stool was passed six days after operation. Brawny induration, present over the lower abdominal wall, back and thighs during the first ten days, finally subsided. Jaundice disappeared slowly. He improved gradually and was finally discharged about 4 weeks after operation. He was gaining weight and progressing satisfactorily when last seen 3 months later.

Buckley and Wells⁵ reported five cases of volvulus in the newborn, confirmed at autopsy.

In 20 patients with disturbances of developmental rotation of the intestine reported by McIntosh and Donovan,⁶ six had volvulus of a part of the intestine derived from the midgut. One of these was associated with atresia of the ileum; one was associated with malrotation and situs inversus abdominalis parietalis; and three were associated with obstruction of the duodenum by persistent peritoneal bands. The youngest surviving patient in this group was operated on when five days old and did not require resection of the involved bowel.

The importance of postoperative adhesions in the etiology of volvulus is emphasized by our experience. Twenty-five patients (69 per cent) had one or more previous laparotomies and, in 23 of these, an earlier operation was almost certainly responsible for the development of volvulus. In 21 of these 23 cases the cause was adhesions, while volvulus occurred about a colostomy and an enterostomy in the others. The average interval between the last preceding operation and the onset of volvulus was approximately seven years. Two patients developed volvulus within 15 days after operation.

It is of interest that 18 of these patients had no obstructive symptoms prior to the onset of volvulus. There had been bouts of abdominal pain suggesting partial small bowel obstruction in seven patients. Two of them had symptoms that suggested an earlier volvulus that had subsided.

Eleven cases had no previous laparotomy. Seven of these had fibrous bands, probably congenital, which were thought to be the cause of the volvulus. The fibrous band extended from the tip of a Meckel's diverticulum to the anterior abdominal wall in two of them. Small bowel volvulus in one patient had occurred about the base of a volvulus of the sigmoid. No abnormality to account for the volvulus was found in the other three patients.

Fourteen of the 37 cases reported by McKechnie and Priestley⁸ had previous operation, and in 21 cases peritoneal adhesions were found to be the predisposing cause. Eight of their cases had congenital anomalies, while 26 had some acquired predisposing cause. No demonstrable cause was found in three instances.

Kohn *et al.*⁷ were able to find in the literature reports of 76 cases of volvulus complicating pregnancy and they added two of their own. Nineteen of these involved the small intestine. One of our patients developed volvulus during the eighth month of pregnancy and is reported here because of the apparent rarity of this association.

ACUTE VOLVULUS OF SMALL INTESTINE

Case 2.—S. S. (183288) A 23-year-old white woman was admitted to Rochester Municipal Hospital May 20, 1942. On the morning of admission she developed severe crampy generalized abdominal pain. This shifted to the right upper quadrant, became constant, and radiated to the right back area. It was associated with nausea and vomiting.

She had an appendectomy 7 years before admission and 2 years before admission had an episode of intestinal obstruction which required operation for release of adhesions. She was known to have diverticulitis of the sigmoid colon and rheumatic heart disease, with mitral stenosis and insufficiency. Three months before admission she had a similar acute episode of abdominal pain, nausea and vomiting. At that time her leukocyte count was 23,000. Her symptoms subsided after a few days of expectant treatment.

The patient appeared acutely ill and moderately dehydrated on admission—T 37° C., P 90, R 20. Abdominal examination revealed marked tenderness in the epigastrium with referred rebound tenderness to this area. No peristaltic sounds could be heard. Roentgenograms were not obtained.

TABLE I.—*Characteristics of Abdominal Pain Recorded in 32 Patients with Volvulus of Small Intestine.*

Severity		Character		Localization	
No.	Per Cent	No.	Per Cent	No.	Per Cent
Severe.....	22 68.8	Cramplike.....	25 78.1	Generalized.....	4 12.5 (without further localization)
Moderate.....	3 9.4	Not cramplike.....	5 15.6	Upper abdominal.....	14 43.8 Epigastric..... 13 R.U.Q..... 1
Severity not stated	7 21.8	Character not stated	2 6.3	Para-umbilical.....	8 25.0 Lower abdominal..... 5 15.6 R.L.Q..... 1 Lower abdominal..... 4 (without further localization)
				Localization not stated.....	1 3.1
Total.....	32		32		32

She was given intravenous fluids and Wangensteen suction but failed to improve. At operation on the day after admission a 12-inch segment of ileum was found to be gangrenous and twisted about an adhesion attaching the apex of the volvulus to the anterior abdominal wall. The involved loop of ileum was resected and an end-to-end anastomosis carried out. Corpus luteum hormone had been given the patient prior to operation but 5 hours postoperatively she delivered a stillborn child. Her convalescence was otherwise uneventful and she was discharged from the hospital on her sixteenth postoperative day. Two days later she was re-admitted with abdominal pain which subsided after a short period of decompression. She subsequently became pregnant again and gave birth to a normal infant. There have been no further symptoms of intestinal obstruction.

PREOPERATIVE DIAGNOSIS

No preoperative diagnosis was recorded in eight cases. Of the remaining 28 cases, the diagnosis of small bowel obstruction was made in 17 instances (47.2

per cent). The diagnosis of volvulus was made correctly in seven. Among the wrong diagnoses were mesenteric thrombosis, abdominal abscess, large bowel obstruction, acute appendicitis, gastro-intestinal cancer, intra-abdominal hemorrhage, perforated duodenal ulcer, acute gallbladder disease, and twisted ovarian cyst.

In patients seen relatively late, the diagnosis of intestinal obstruction was usually obvious, whereas the cause of the obstruction was obscure. In those seen shortly after onset of initial pain the problem was more that of a differential diagnosis of the acute abdomen and clinical intestinal obstruction frequently had not yet developed.

Symptoms. The pain of which the patients complained varied in localization, severity and character.

From Table I it can be seen that the majority of the patients had severe cramplike upper abdominal or para-umbilical pain.

Nausea and vomiting were usually prominent features of the history. Only two patients had neither of these symptoms. Vomitus was "fecal" or very foul in seven cases.

Diarrhea was a prominent symptom in only one patient. Fourteen patients had some degree of constipation ranging from no bowel movements in 24 hours in six patients to none in six days for one patient.

Only two patients had macroscopic evidence of blood in their stools.

Signs. The most common findings on examination were tenderness and abdominal distention.

There was no typical site of tenderness in this group, the localization depending chiefly on the location of the involved loop of bowel and upon the state of viability of the loop. In the more advanced cases the presence of bloody fluid or peritonitis usually but not invariably led to generalized tenderness.

Tenderness, present in 31 patients, was generalized in 14 and localized in the remainder. All areas were represented in those showing localized tenderness. In four cases, no mention was made of tenderness, and in one case it was recorded as absent.

Distention was present in 25 and absent in six cases. It was marked in ten, moderate in ten and only slight in five cases.

The presence or absence of peristalsis was noted in only 21 cases. There was marked increases in peristalsis up to borborygmus in 11 of these and only slight increase in one patient. Those in whom peristalsis was decreased or absent were the comparatively late cases as one would expect.

The degree of spasm present was somewhat surprising. Spasm was present in 12 and absent in 13 of the 25 in which a note was made regarding abdominal spasm.

Fluid within the abdominal cavity was noted on physical examination in only seven of these patients. However, an appreciable amount of ascitic fluid was present in 18 patients at operation.

An abdominal mass was palpated in six patients; two in the left lower quadrant, two in the right lower quadrant, one in the left upper quadrant and one extending transversely across the mid-abdomen.

In the McKechnie and Priestley⁸ series, seven cases, including two of those with acute volvulus, had no significant abdominal findings on examination. Physical examination "commonly reveals distention, tenderness and rigidity." Pain was present in 85.7 per cent, nausea and vomiting in 74.3 per cent, constipation in 51.4 per cent and distention in only 11.4 per cent. The pain was colic-like in 45.7 per cent and steady in 37.2 per cent.

In the series reported by Leonard and Derow⁹ abdominal pain and vomiting were present in 100 per cent, constipation was present in 30 per cent and distention was present in 37 per cent. Abdominal tenderness and rigidity were found rarely in their series.

TABLE II.—*Summary of Abdominal Signs in 36 Cases of Volvulus.*

Sign	Number of	
	Pts. With	Per Cent
I. Tenderness.....	31	86
Marked.....	11	
Moderate.....	14	
Slight.....	6	
Localization of tenderness		
Generalized.....	14	
Para-umbilical.....	3	
Upper abdominal.....	5	
Lower abdominal.....	10	
II. Distention.....	25	69
III. Peristalsis increased.....	12	
Decreased to absent.....	7	
IV. Spasm		
Present.....	12	33
Absent.....	13	
V. Peritoneal fluid		
Present by examination.....	7	
Present at operation.....	18	50
VI. Abdominal mass present on examination.....	6	
VII. X-ray film of abdomen.....	27	
Evidence of small bowel obstruction.....	19	70 (*)

* Percentage based on number of patients (27) who had roentgen ray film of abdomen taken.

Roentgenograms. A roentgenogram of the abdomen was taken in 27 patients. Nineteen of them showed evidence of small bowel obstruction; two showed evidence of large bowel obstruction; one showed free air in the right upper quadrant with evidence of fluid in the peritoneal cavity (Figure 1). The roentgenograms appeared normal in five patients.

A summary of the physical signs is presented in Table II.

Laboratory Findings and Vital Signs. In general, the temperature, pulse and respiration were of little value as indications of the pathologic condition within the abdomen. Only six patients had a temperature greater than 38°C. and in 12 patients the temperature was 37°C. or less. In those patients requiring bowel resection, the pulse rate averaged 110, but this too was unreliable.

The degree of leukocytosis roughly corresponded to the degree of strangulation of the involved loop of bowel in many cases. The average white blood count in the 31 cases in which these figures were available was 16,200. Of the 14 cases in which resection or exteriorization was obligatory, the average leukocyte count was 18,820. In those with operation not requiring resection the average was 14,600. Nineteen (61 per cent) of the 31 had at least a 14,000 white blood cell count. The highest count was 39,200 and the lowest was 4600. Certainly other factors, such as state of hydration, affect the total leukocytes, but in general the higher degrees of leukocytosis were associated with serious impairment of the circulation to the involved loops of bowel.

The discrepancy between our findings and the observation by McKechnie and Priestley⁸ that the "leukocyte count is usually approximately normal except in acute cases where it may be slightly elevated." may be explained by their unusually low (16 per cent) incidence of seriously impaired circulation in the affected loop. McKittrick and Sarris¹⁰ have stressed the importance of increasing leukocytosis in successive blood counts. They feel that this suggests strangulation of the intestine. Our observations support this thesis.

TABLE III.—*Relationship Between Type of Surgery and Mortality Rate.*

Operative Procedure	No. Cases	No. of Deaths	Mortality Rate
1. Release fibrous band with untwisting of volvulus	17	1	5.9%
2. Laparotomy—untwisted prior to operation	1	0	0
3. Resection with primary anastomosis	13	6	46.2%
4. Exteriorization with side-to-side entero-enterostomy	1	1	100 %
5. No operation for volvulus	4	4	100 %
Total	36	12	33.3%

Peritoneal Fluid. The presence of free fluid in the peritoneal cavity was noted at operation in 18 patients. This fluid was bloody in 11, frankly purulent in one and serous in six instances. Seven of 11 cases with bloody fluid required resection for non-viable bowel, while only two of the six cases with serous fluid required resection. One should suspect the presence of gangrenous loops of bowel in those with bloody fluid in the peritoneal cavity and elect early surgery.

Treatment and Prognosis. Our high mortality rate, 33.3 per cent, compares favorably with other reported series (Table III).

Leonard and Derow⁹ reported 16 cases of small bowel volvulus with nine deaths, a mortality rate of 56 per cent. Seven of these nine deaths followed more extensive surgery than simple untwisting. The five enterostomies and two resections in their series all ended fatally. Skjold² reports two deaths in six patients with volvulus, without stating whether or not these occurred in small bowel. McKechnie and Priestley⁸ reported 34 cases with six deaths, but only 21 of these cases were classified as acute volvulus of the small bowel. If, as seems probable, these six deaths occurred in acute volvulus, their mortality

rate for acute volvulus would be 28.6 per cent. Michael,¹¹ in reporting 160 cases of obstruction not due to cancer, included 11 cases of volvulus. One of these patients died shortly after admission without surgical intervention, and the remaining ten were operated upon. Five cases survived simple release of adhesions and five cases died after other operative procedures.

Only one of our 18 cases requiring only release of adhesion with untwisting of the volvulus ended fatally. This death was due to coronary thrombosis. Certainly this is the best method of treatment when it suffices. However, when the loop is gangrenous, resection is necessary. Thirteen patients in our series required resection. Six of them died, all within three days of operation. Exteriorization with side-to-side anastomosis might have been tried but probably would not have altered the fatal outcome. This procedure was carried out in one case, but the patient succumbed within 24 hours. In one case laparotomy was performed and evidence of previous volvulus, which had already untwisted itself at time of operation, was found.

One hundred per cent mortality occurred in the group in which no operation was carried out for the volvulus. Two patients were seen too late and in too poor condition to stand surgery. In one case, surgery was directed at strangulated hernia without laparotomy. In the other, a mid-thigh amputation was done for gangrene but no laparotomy was done.

The relationship between the mortality rate and the duration of symptoms prior to operation is of particular interest. The average duration of illness before operation in 12 fatal cases was more than six days. In the 23 patients who survived, the average interval was less than two days. Only one case with symptoms over three and a half days survived, and only one case with symptoms less than 36 hours died. The patient who lived with symptoms over three and a half days had a six-day history of symptoms before admission and had partial relief with a Miller-Abbott tube. Four days after admission he was operated upon, at which time the bowel was not gangrenous. Its color returned to normal after release of fibrous band and no resection was necessary. The patient who died with symptoms of less than 36 hours developed a postoperative obstruction from a kinking of the bowel, requiring a second operation on the third postoperative day. He died two days later with generalized peritonitis.

Leonard and Derow⁹ noted that the average duration of symptoms in patients with volvulus of the small bowel before operation was 48 hours in nine fatal cases, while in the seven non-fatal cases the interval averaged 38 hours. They concluded that this delay of ten hours might have accounted for the fatalities.

The need for early operation is illustrated by one patient who was operated upon two hours after the onset of symptoms. A foot of ileum was found to be gangrenous and required resection. Dennis and Brown¹² stressed the importance of early operation in patients with obstruction of small bowel especially when signs of peritoneal irritation are present.

McKittrick and Sarris¹⁰ stressed the increased hazards of small bowel obstruction in old patients. In their series of acute intestinal obstruction of the small bowel from all causes, the mortality rate was 64 per cent in patients over 60 years of age. Eleven patients in our group were over 60 years of age and only three of these survived, a mortality rate of 72.7 per cent. Twenty-four patients under 60 years of age had a mortality rate of 16.4 per cent.

Improvement in our understanding of volvulus would be a cause for optimism. A comparison was made between the first 18 cases in this series, admitted prior to July 1, 1940, and the last 18 cases, admitted subsequent to that date.* In the first 18 cases there were eight deaths, while in the last 18 cases there were four deaths, with resulting mortality rates of 44 per cent before July, 1940, and 22 per cent after July, 1940. Most of the improvement was probably due to more adequate fluid replacement, blood transfusions, decompression by Miller-Abbott tube and chemotherapy. In the more recent group more patients entered the hospital promptly after the onset of symptoms and more were operated upon without delay. McKittrick and Sarris¹⁰ ascribe their recent improvement in results to the fact that more patients were operated on within 24 hours after the onset of symptoms. Our series is too small to be significant in this respect, but more prompt treatment appears to have been an important factor.

A study of the fatal cases is of interest. In only three of these patients was there any likelihood that death might have been prevented. Errors in diagnosis in each case led to delay in surgical treatment, thereby decreasing chance of survival.

One patient was observed on Medical service for three days before surgical consultation was sought. At operation generalized peritonitis was present. Gangrenous jejunum was resected and end-to-end anastomosis was performed. The patient died 24 hours later. Prompt surgical consultation and operation probably would have prevented this death.

Another patient was observed on Surgical service for 24 hours before operation. A tender mass was present on admission in the right lower quadrant and serous fluid was obtained by abdominal tap. Roentgen ray examination of abdomen showed no evidence of bowel obstruction. Delay in operation was justifiable, since a diagnosis of abdominal abscess was made. At operation 24 hours after admission, resection of two feet of small bowel was necessary. The patient died 40 hours later with peritonitis in spite of an intact anastomosis. Immediate laparotomy before onset of peritonitis might have been life-saving.

The third possibly preventable death was that of a 74-year-old woman who was admitted with partial large bowel obstruction due to carcinoma of sigmoid. A cecostomy done shortly after admission failed to relieve her symptoms. Two days later laparotomy revealed a gangrenous loop of jejunum and ileum twisted about the adhesions to a midline incision made many years before.

* These two groups are fairly comparable as to number resected (7:6); number untwisted (8:10); number not operated on (2:2); number exteriorized (1:0).

Death occurred seven hours after resection of this gangrenous bowel, from cardiovascular collapse. Recognition and treatment of the volvulus at the time the cecostomy was performed might have prevented this fatality.

The other deaths were for all practical purposes unpreventable. Four were too late on admission; two probably developed the volvulus as a terminal event without causative relationship to the fatality, and three died because of some other uncontrollable factor.

DISCUSSION AND CONCLUSIONS

The chief difficulty lies in differentiating between the various causes of symptoms of small bowel obstruction, presented by most of these patients.

If the physical examination, history and laboratory findings suggest the probability of strangulation of bowel, then early operation is advisable, even if there is some improvement in condition with decompression. The presence of fluid, either on examination or tap, indicates need of operation.

In our experience we have seen no harm result from a diagnostic abdominal tap. We feel that this should be attempted in the doubtful cases. Within four hours after experimentally producing strangulation of loops of jejunum Hill *et al.*¹³ found that bloody fluid was present in the peritoneal cavity which could be aspirated. If free fluid is obtained, laparotomy should be advised. If the peritoneal fluid is bloody, operation is practically mandatory.

The presence of a tender mass in the abdomen associated with obstruction should demand exploration.

Marked leukocytosis, pulse elevation or fever beyond that expected from state of hydration should make one suspect strangulation of bowel.

Absence of spasm should not influence observer against diagnosis of volvulus. The presence of persisting tenderness almost anywhere in abdomen is in favor of volvulus or some other form of strangulating obstruction and should indicate exploration.

Wangensteen¹⁴ emphasizes the importance of tenderness in the presence of intestinal obstruction. When this is present on admission or when it develops in a patient whose findings are otherwise those of simple obstruction, he favors early operation.

McKittrick and Sarris,¹⁰ in an excellent presentation of small bowel obstruction, concluded that, because of the difficulty in differentiating between simple and strangulating obstruction, early operation is advisable in all cases of small bowel obstruction seen within 48 hours after onset of symptoms.

Most important is to make a determined effort to ascertain the presence or absence of volvulus or strangulation in all cases of small bowel obstruction. It will not suffice simply to diagnose small bowel obstruction and to start decompression from above. Careful observation must be continued and the possibility of the need for surgical intervention must be kept in mind. McKittrick and Sarris¹⁰ point out in their series of 136 cases of small bowel obstruction that if there was a delay of operation for six hours there was invariably a delay of

at least 24 hours, the average delay in this group being 48 hours. They recommend a twice daily leukocyte count in any patient being observed and believe that a rising count is of more significance than a single high or low determination.

The type of operation to be performed depends upon the conditions found when the abdomen is opened. If simple release of the adhesion with detorsion of the volvulus is all that is required then this is the procedure of choice. Frequently a markedly strangulated loop of bowel will give evidence of viability after release and application of warm packs to the loop of bowel. If after ten to 12 minutes, there is no evidence of the bowel being viable, or if there is serious doubt as to its viability, the preferred treatment is resection of the strangulated bowel with adequate margin and an end-to-end anastomosis. As demonstrated in this series of cases, most patients will tolerate this procedure quite well. In an extremely poor risk patient, exteriorization may be permissible. Gatch¹⁵ advocated this procedure with the establishment of a "gun barrel" enterostomy for those in whom there was great distention of the bowel, the anastomosis to be performed after recovery from the acute illness.

Dennis and Brown¹² have had considerable success in performing primary aseptic anastomosis in the presence of marked degrees of obstruction and gangrenous bowel. They stressed the benefits of local implantation of sulfathiazole in the emergency cases where preoperative succinyl sulfathiazole could not be given.

McKittrick and Sarris¹⁰ pointed out that it is not so much the magnitude of the operation that is responsible for the higher mortality where more extensive operations are required as the advanced stage of the disease and the associated complications such as peritonitis. Morton¹⁶ emphasizes the need for gentle handling of the tissues and for limiting the amount of surgery performed to that actually necessary to relieve the condition found at operation. Any added procedure is meddling surgery and adds an unnecessary risk. Orr¹⁷ stated that the briefest operation with the least possible trauma is the procedure of choice. He states that although enterostomy may be life saving and may be the only operative procedure necessary for bowel obstruction, it will not suffice where there is strangulation. One is impressed in reviewing the literature on this subject by the number of cases treated by enterostomy and the high percentage of deaths following this procedure.

Wangensteen¹⁴ states that primary resection of strangulated bowel with primary end-to-end anastomosis is to be preferred to an exteriorization operation.

The more adequate pre- and postoperative treatment with proper fluid replacement therapy has played an important part in decreasing the mortality from this condition. Sulfonamides and penicillin have aided greatly. The advent of the Miller-Abbott tube has aided considerably but is not without danger. The only way in which these results can be materially improved is by earlier diagnosis and earlier surgery.

SUMMARY

Thirty-six cases of acute volvulus of the small bowel occurring in the Strong Memorial Hospital and Rochester Municipal Hospital between 1925 and 1947 are analyzed.

A case history is presented of a 52-hour-old infant treated successfully by resection of the involved perforated loop of ileum with primary end-to-end anastomosis. Another case is presented of a volvulus occurring in a woman, seven months pregnant, treated successfully by resection and primary anastomosis.

Twenty-five (69.4 per cent) of these cases had had previous laparotomy, and in 28 (77.7 per cent) patients either acquired or congenital fibrous bands were thought to be the principal predisposing cause of volvulus.

The most frequent preoperative diagnosis was small bowel obstruction.

The usual symptoms were severe, cramplike, upper abdominal or para-umbilical pain associated with nausea and vomiting.

The usual signs included abdominal tenderness (86 per cent), and abdominal distention (69 per cent). Peristalsis ranged from absent (usually in the late cases) to hyperactive. Spasm of the abdominal muscles was present in only 12 of the 25 cases in which the presence or absence of spasm was recorded. Evidence of small bowel obstruction by roentgen ray was usual (70 per cent).

The average leukocyte count in those requiring removal of the bowel for gangrene was 18,800; in those in whom detorsion of the volvulus was all that was required the average was 14,600.

The mortality rate of this group of 36 patients with acute volvulus was 33.3 per cent.

In 18 cases no more extensive surgery than release of fibrous band and untwisting of the volvulus was necessary. Only one of this group died (5.5 per cent). In 14 cases either resection with end-to-end anastomosis (13) or exteriorization (1) was done. Seven (50 per cent) of this group died. In four cases, no surgery was performed for the volvulus and all four of these died.

Of considerable importance in the prognosis is the duration of symptoms prior to operation and the age of the patient. The average duration in the fatal cases was approximately six days, while in the non-fatal cases the average duration was less than two days. The mortality rate in those over 60 years of age was 72.7 per cent and in those under this age was 16.4 per cent. The mortality rate prior to July, 1940, (18 patients) was 44 per cent and after July, 1940, (18 patients) was 22 per cent.

Satisfactory treatment of this condition requires an early diagnosis. Diagnosis of the cause of the obstruction rather than simply the presence of intestinal obstruction is one of the chief difficulties encountered.

The proper surgical treatment depends upon the conditions found at operation. In general, the simplest procedure with the least trauma is best. Severing the constricting band and untwisting the volvulus suffices in many. If

the bowel wall is gangrenous, then resection with end-to-end anastomosis is advocated.

BIBLIOGRAPHY

- ¹ Sweet, R. H.: Volvulus of the Caecum. *New England J. Med.*, **231**: 287, 1935.
- ² Skjold, A. C.: Bowel Obstruction, An Analysis of 148 Cases. *Minnesota Med.*, **31**: 52, 1948.
- ³ Weible, R. E.: Volvulus: Torsion of the Whole Mesentery: Report of Case with Résumé of the Literature. *Surg., Gynec. & Obst.*, **19**: 644, 1914.
- ⁴ Dott, N. M.: Anomalies of Intestinal Rotation. *Brit. J. Surg.*, **11**: 251, 1923.
- ⁵ Buckley, R. P., and A. H. Wells: Volvulus in Newborn with Report of Five Fatal Cases. *Minnesota Med.*, **27**: 916, 1944.
- ⁶ McIntosh, R., and E. J. Donovan: Disturbances of Rotation of Intestinal Tract. *Am. J. Dis Child.*, **57**: 116, 1939.
- ⁷ Kohn, S. G., H. A. Briele and L. H. Douglas: Volvulus Complicating Pregnancy. *Am. J. Obst. & Gynec.*, **48**: 398, 1944.
- ⁸ McKechnie, R. E., and J. T. Priestley: Volvulus of Small Intestine. *Am. J. Surg.*, **34**: 286, 1936.
- ⁹ Leonard, E. D., and Sidney Derow: Volvulus, A Study of 22 Cases. *New England J. Med.*, **218**: 388, 1938.
- ¹⁰ McKittrick, L. S., and P. S. Sarris: Acute Mechanical Obstruction of Small Bowel. *New England J. Med.*, **222**: 611, 1940.
- ¹¹ Michael, J. H.: 160 Cases of Obstruction due to Non-Malignant Causes. *Ann. Surg.*, **111**: 765, 1940.
- ¹² Dennis, C., and S. P. Brown: Treatment of Small Bowel Obstruction. *Surgery*, **13**: 94, 1943.
- ¹³ Hill, F. C., B. J. O'Loughlin and M. Stoner: Peritoneal Aspiration in the Diagnosis of Strangulated Bowel. *Surg., Gynec. & Obst.*, **74**: 121, 1942.
- ¹⁴ Wangensteen, O. H.: *Intestinal Obstructions*, Charles C. Thomas, Publisher, Springfield, Ill., Second Edition, 1942.
- ¹⁵ Gatch, W. D., H. M. Trusler and K. D. Ayres: Causes of Death in Acute Intestinal Obstruction. *Surg., Gynec. & Obst.*, **46**: 332, 1928.
- ¹⁶ Morton, J. J.: Factors Determining the Selection of Operation in Obstruction of the Small Intestine. *Surgery*, **1**: 848, 1937.
- ¹⁷ Orr, T. G.: The Therapeutic Management of Intestinal Obstruction. *Surgery*, **1**: 838, 1937.