PERFORATION OF THE SIGMOID COLON DURING BARIUM ENEMA

REPORT OF A CASE WITH REVIEW OF THE LITERATURE, AND EXPERIMENTAL STUDY OF THE EFFECT OF BARIUM SULFATE INJECTED INTRAPERITONEALLY*

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DURING THE COURSE of a barium enema on one of our patients, a perforation of the sigmoid colon occurred with spread of the contrast media throughout the abdominal cavity. The patient recovered after a stormy illness marked by repeated occurrences of obstruction of the small intestine. A careful review of the literature has indicated no similar reported occurrence. There have been many reports of colon perforation due to pneumatic pressure, proctoscopy, and saline and soap suds enemas. There have been, however, several reports of perforation of peptic ulcers during barium study. These patients usually have recovered.

CASE REPORT

This 50-year-old white man was first seen by us 3 years before, complaining of abdominal pain and rectal incontinence. His present illness began 29 years previously, when he began to have frequent small stools which contained mucus and pus. In 3 years he required rectal dilatations; in 6 years he developed a perirectal abscess which ruptured and drained spontaneously, and he became aware of the passage of liquid stool and gas through this fistula. By the sixteenth year of his illness, an anal fistulectomy was done, resulting in incontinence. Five years ago two other perirectal abscesses appeared on the buttocks, ruptured spontaneously and continued to drain until admission to the hospital. Twelve days prior to admission he began to have generalized abdominal pain associated with anorexia and diarrhea. Two days later he had a shaking chill followed by a fever as high as 104° F. He continued to have dull abdominal pain and a low-grade fever until admission.

This man appeared emaciated (weight 109 pounds). There was generalized abdominal tenderness without spasm or masses. To the right of the anus there was a fistula surrounded by a large skin ulcer with much scar, and this fistula drained foul material. There were two other fistulous openings approximately 2 inches apart in the right buttock, each surrounded by an area of redness and induration. Digital examination revealed a stricture 5 cm. from the anal orifice. A proctoscope could not be passed beyond this. The Frei test was negative.

A barium enema was then done in the usual manner. The flow of barium was started and was seen to pass to the junction of the descending and sigmoid colon. Multiple diverticula, with changes suggesting inflammation, were present. The flow of barium was continued when it was noted that the lower abdomen was suddenly filled with scattered linear striations of barium extending to the level of the third lumbar vertebra.

The patient complained of severe abdominal pain and soon began to show evidence of progressive shock. He was operated upon within 3 hours. The systolic pressure had fallen to 100 mm. of mercury by this time, despite liberal use of blood and plasma.

Operation (L. J. K.): Under general anesthesia, a left paramedian lower abdominal incision was made. A great deal of bloody fluid mixed with

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barium escaped. As much as possible was aspirated, but a paste-like emulsion of barium clung to all the tissues and attempts to wash this out with saline were unsuccessful. There was a V-shaped rent, 4 cm. long, on the anterior surface of the sigmoid, just above the peritoneal reflexion in an obviously diseased and indurated area. A biopsy was taken, the rent sutured with fine catgut and reinforced with surrounding fat pads. A transverse colostomy was done but not opened until later and 4 large rubber dam drains were inserted in the left lower quadrant of the abdomen through a stab wound. Microscopic study of tissue removed from the sigmoid at the margin of the perforation showed acute fibrinopurulent and subacute changes of a nonspecific nature.

His recovery was slow despite the aid of gastric suction with a Levin tube, oxygen by means of the Boothby mask, and antibiotics. He was given penicillin and streptomycin. By the fifth day postoperatively, however, peristaltic sounds were heard and the colostomy functioned well. That night he developed difficulty and the Levin tube was reinserted and gastric suction maintained two days. The stab wound in the left lower quadrant of the abdomen drained serosanguineous material but this soon diminished and almost disappeared until the eighth day postoperatively, when profuse drainage of purulent material occurred with a fistulous connection to the repaired sigmoid. This gradually closed and the perirectal fistulas healed by the time of discharge from the hospital.

The patient returned to the hospital 2 months later with a first of a series of obstructions of the small intestine. This proved to be a partial one. It continued, and he was again operated upon. Obstruction of the terminal ileum was found and released. An additional bout of intestinal obstruction occurred during this hospitalization but subsided with gastric suction, using a Levin tube. Two months later a gangrenous loop of small bowel, 3 feet long, was removed after the rapid onset of obstruction. A proximal enterostomy was done and functioned poorly. The peritoneum as such was found obliterated. Multiple granulomatous lesions surrounding accumulations of barium were seen (Fig. 1). A fecal fistula developed which persisted, although he did relatively well. One month later he developed a right posterior subphrenic space abscess which was drained through the twelfth rib bed. It was apparent that the subphrenic abscess connected with the abscess at the site of the fecal fistula. The latter promptly healed.

He continued to have attacks of intestinal obstruction which were relieved by gastric suction. He was required to remain on a liquid diet, lost weight, and the situation became intolerable. Therefore, 40 days after the time of large bowel perforation he was again operated upon. The entire small bowel from the ligament of Treitz to the ileocecal valve was liberated. Some of the adhesions were so filled with barium as to be almost frozen, and they repeatedly dulled the knife blade. A partial obstruction was present at the site of the fecal fistula, which had recurred, this being proximal to the previous anastomotic line. Twenty centimeters of bowel were resected. Large sheets of Gelfoam were laid over the raw areas of the bowel as well as underlying the incision. After a stormy postoperative course, he recovered and now is doing well (2 years later).

DISCUSSION

There can be no doubt that the perforation occurred in diseased bowel. It seems significant that the patient received cleansing enemas in preparation for his roentgen study, yet did not perforate at that time. It may be that the pre-examination enemas weakened the bowel, or that they had no effect on the perforation. It is possible that the added pressure caused by the barium as opposed to water was enough to make the difference. Regardless of the possible causes, this case demonstrates the care that must be exercised in the administration of enemas, especially when diseased bowel is suspected.

Burt[7] determined the amount of pressure that the bowel could withstand prior to rupture, studying *in vitro*. He found that upon increasing the intraluminal pressure, the outer two coats would rupture first in a longitudinal direction and that the mucosa would herniate through this aperture. Then upon increasing the pressure still further the mucosa would perforate. He found that the average pressure prior to rupture of the outer two coats was 3.49 pounds/square inch (18 cm. of mercury) and that the average pressure required to perforate the mucosa was 4.07 pounds/square inch (21 cm. of mercury). He also found that the rectum could support the greatest intraluminal pressure followed in order by the sigmoid, ileum, esophagus, jejunum, transverse colon, cecum and stomach. Our patient re-

ceived his barium from a height of 3 feet, and since the specific gravity of the mixture was 1.070, the pressure at the tip of the tube was equivalent to 7.66 cm. of mercury. This is considerably less than the figures of Burt, which indicates that the perforation occurred in diseased bowel. He further showed that it required less intraluminal pressure to cause perforation if the air is given rapidly. Ballon and Goldbloom[4] reported on serious injuries to the rectum from improperly administered enemas. They felt that two factors were involved; the hard nozzle of the enema tip and hydrostatic pressure of the administered material. Certainly the former was not a factor in our patient. They point out that injury to the insensitive rectum will cause little pain.

Perforations of the rectum and sigmoid have been reported due to ordinary enemas,[3, 7, 12] water hydrant injuries,[21] proctoscopy,[2] pneumatic rupture,[14] and barium sulfate enemas.[11]

The mortality has proved to be high with these perforations. Pratt and Jackman[17] reviewed the literature in 1945 and found 20 cases of perforation of the rectal wall by enema tips. Eight of these were intraperitoneal perforations and 50 per cent died. They cautioned against inserting the enema tube more than two inches into the rectum and pointed out that the rupture usually occurs on the anterior wall of the bowel. They properly advised early operation with closure of the perforated bowel.

Andresen[2] in 1947 was able to accumulate 46 cases of perforations during proctoscopy. His findings indicated that after six hours the mortality doubled, and that after 12 hours it tripled. Sudden severe pain occurred in 55 per cent and shock in 13 per cent of the patients. Thirty-four were oper-

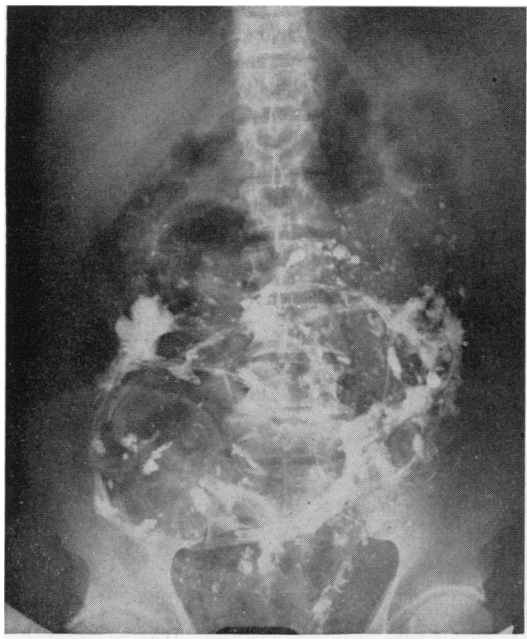

FIG. 1

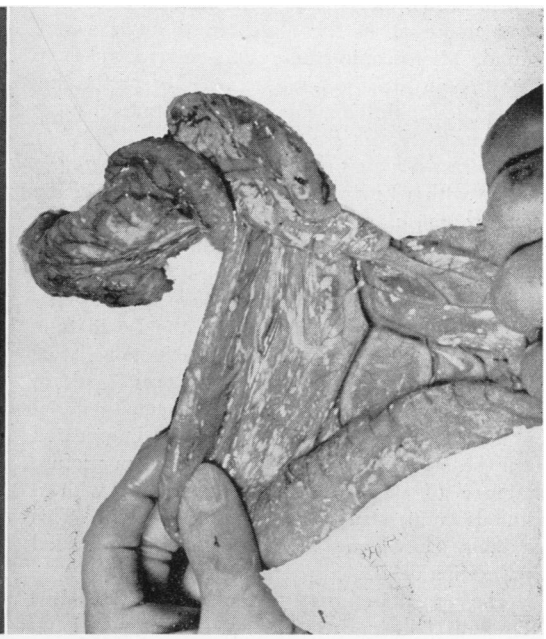

FIG. 2

FIG. 1.—Anteroposterior roentgenogram of the abdomen showing many deposits of barium sulphate in the peritoneal cavity.

FIG. 2.—Dog 24, in which 150 ml. of barium sulphate suspension was placed intraperitoneally seven months previously. There were no significant adhesions but the barium deposits are apparent.

ated upon with 11 deaths (32 per cent mortality) and 12 were not operated upon with eight deaths (66 per cent mortality). In those who were operated upon immediately there was an 8 per cent mortality.

When one comes to consider the problem of barium sulfate escaping into the peritoneal cavity, there are several possibilities. Golub[10] discussed some of the dangers in its use:

1. Accidental poisoning due to impurity of the material. Barium sulfate is insoluble and safe, but it must be free of poisonous soluble barium salts.
2. Ulcer perforation (peptic).
3. Undue retention of the barium, causing obstruction.

Obviously another possibility is perforation of the colon. Several instances of peptic ulcer perforation have been reported,[1, 5, 9, 11, 13, 16, 18, 19] with recovery being frequent after operative closure of the perforation. By 1932 Himmelmann[11] found 39 previously reported perforations in the region of the stomach and duodenum during the administration of barium sulfate by mouth. He was able to report five cases of his own. Singer[18] in 1934 found 36 reported cases of this type.

In contrast there are few reported cases of survival of the patient after perforation of the colon during the administration of barium sulfate during roentgenographic study. We are, therefore, encouraged to report this case and feel that the aid of antibiotics, the proper treatment of water and electrolyte imbalance which at that time was considerable, and the careful nutritional support of this patient contributed heavily to his survival. It is felt that the higher incidence of survival after perforation of the stomach and duodenum and spillage of barium into the peritoneal cavity than after colon perforation is merely the difference in bacterial contamination. We were encouraged to make several experimental observations.

EXPERIMENTAL OBSERVATIONS

In an attempt to reproduce experimentally the effect of barium in the peritoneal cavity, six dogs, each weighing about 7 Kg., were injected intraperitoneally, with heavy barium sulfate solutions, using amounts varying from 20-150 ml. in an attempt to produce intraperitoneal adhesions. All survived except one that died two months later of other causes. No significant adhesions occurred except in one dog who had 50 ml. injected intraperitoneally, and a moderately dense nest of adhesions of the ileum in the left lower quadrant was seen four months later. As in all other studies done, the typical finding was a barium granuloma on the surface of the gut and peritoneum (Fig. 2). There is early acute inflammation with free peritoneal fluid, edema and congestion of the bowel, and later there are merely patchy areas of

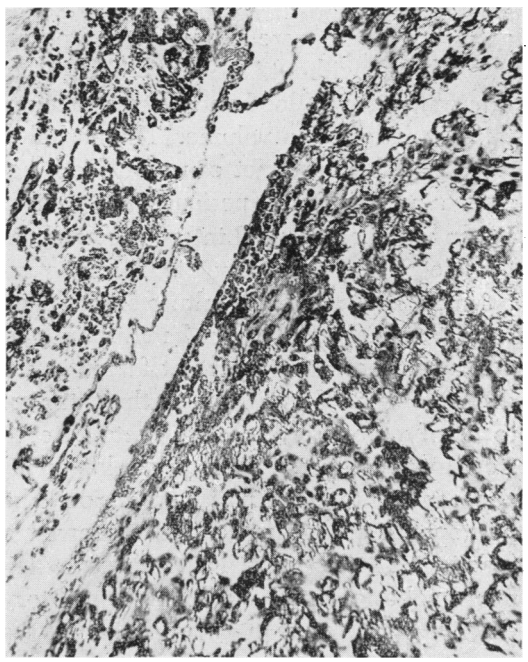

FIG. 3.—Photomicrograph of barium sulphate deposits on the peritoneum of a dog (No. 66) in which a suspension of barium sulphate had been injected intraperitoneally three and a half months previously.

chronic inflammation and barium granulomata (Fig. 3).

In an attempt to clarify the problem further a mixture of barium and stool was injected intraperitoneally in two dogs, who died in 48 hours without any significant findings. Ebert, Hagen, and Borden[8] injected 50 ml. of a thin suspension of feces in saline into the peritoneal cavity. One group of dogs were allowed to progress into shock without therapy. The other group was given blood and plasma to maintain normal plasma volume. The mortality was high and the exact cause of death not ascertained. Our experience is similar. When we injected stool intraperitoneally in two dogs, they promptly died. In the experiment of Ebert *et al.* culture of the blood consistently showed colon bacilli, and this must have been an important factor in the death of these dogs. In a further attempt to clarify the problem we injected sterile stool intraperitoneally into three dogs. This apparently produced no severe lesion. The peritoneum of one animal only showed a reaction. In this animal on the sixth day many adhesions and marked inflammatory reaction were seen. In six weeks there was much less. One dog was followed for three and one-half months with no severe reaction.

It would thus appear that the presence of the organisms was the sole cause of the extreme peritoneal reaction and death of the animals, and that neither barium alone or sterile stool caused the marked adhesions found in human beings. In order to eliminate a so-called toxic factor, some stool was filtered with a Zeitz filter and the material injected. Again, in two dogs, one followed three and one-half months, no change was seen.

SUMMARY

1. An instance of perforation of the colon during the performance of barium enema is reported, with survival of the patient after a stormy course. It is felt that this individual's survival is partially attributable to the use of antibiotics and the proper care of water and electrolyte problems.

2. Experimental observations on dogs indicate that moderate amounts of barium will not produce intestinal adhesions and that the complicating factor of infection is more important.

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