Rupture of Colon in Infants During Barium Enema: Report of Two Cases *

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IN THIS ERA of complicated procedures, such as angiocardiograms, aortograms, cerebral angiograms, et cetera, with their attendant risks, it seems wise to report serious complications accompanying such a simple and innocuous procedure as barium enema study of the colon. As medical care becomes more complicated and more costly, it is only natural that certain procedures are delegated to technicians in order to spare the time of more highly educated and more expensive personnel. Thus, the technical side of barium enema, such as insertion of the tube, blowing up of the balloon and the instillation of the barium suspension, is usually placed in the hands of the technician.

The two cases of rupture of the colon during barium enema which I wish to report, along with a review of the literature on the subject, demonstrate what I believe to be the mechanism of this tragedy and the treatment necessary when it occurs. It also should serve to remind us all of our personal responsibility when we order even such a simple test as barium enema.

The first patient, H. W., an infant boy, was 4 days old on admission to the hospital. This boy was born of a normal delivery, had no cyanosis and no convulsions at birth. It was reported that the cord was wrapped tightly around the neck, that he had a lot of mucus, and that he had a large meconium stool at birth. His birth weight was 6 pounds (2.72 Kg.). He began vomiting as soon as he was fed. This started mildly but gradually became more frequent, more severe, and projectile. In spite of the vomiting, he was having three to five stools a day.

Examination revealed the baby to be lethargic, but he cried lustily when awakened. He was not dehydrated. There were no abnormal physical findings and no evidence of congenital anomalies. On admission blood count showed 5,290,000 red blood cells, 17 Gm. hemoglobin, 8,600 white blood cells, 17 segmented neutrophils, 75 lymphocytes, 1 monocyte, and 7 eosinophils. An admitting diagnosis of possible congenital intestinal obstruction or possible anoxic brain damage was made.

After 24 hours of vomiting and five bowel movements, all very small, dark green and mostly of meconium, a barium enema was ordered.

The abdominal scout film revealed a moderate amount of intestinal gas both in small and large bowel. There were no distended loops of bowel to suggest obstruction. As soon as barium was injected, it was seen to spread over the abdominal cavity. The infant was put back to bed and fluids started by vein and blood cross matched for transfusion.

The baby was operated two hours after the barium enema. A low left rectus muscle splitting incision was made. On entering the peritoneal

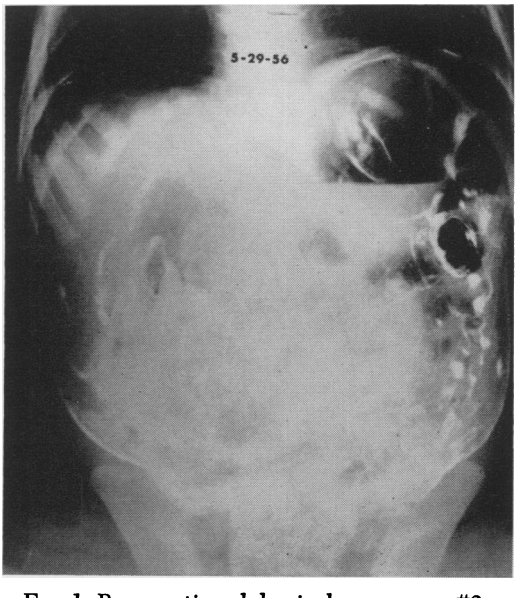

FIG. 1. Preoperative abdominal x-ray, case #2.

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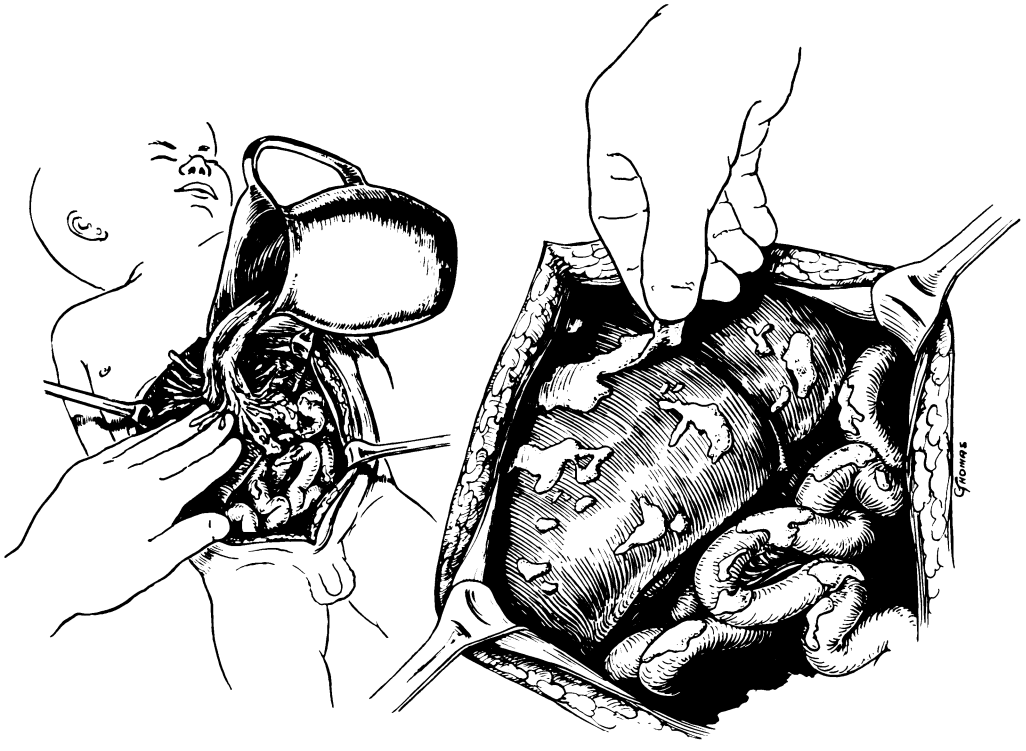

FIG. 2. Abdominal findings at surgery, case #2.

cavity a large amount of barium and liquid stool was encountered. This along with flakes of barium was removed and the abdomen was freely flushed with saline.

Exploration revealed no obstruction or malrotation. No barium was found in the lumen of the colon. A 3 cm. longitudinal tear of the rectum was found, beginning at the peritoneal reflection. This was closed and a transverse colostomy performed. The abdomen was closed without drainage and the child returned to his room in good condition, except for slight cyanosis. This cyanosis disappeared in about two hours.

The baby remained in good condition for 30 hours at which time he again became cyanotic. This was improved by suction of mucus from the trachea and administration of oxygen. The cyanosis recurred in six hours and the baby expired 37 hours after operation.

Autopsy revealed no congenital anomaly of the gastro-intestinal tract. A small patent ductus arteriosus was present. The foramen ovale was also patent but covered by a valve like structure of the septum. The abdominal cavity revealed a generalized fibrinopurulent peritonitis with no localized collections of fluid. The lungs showed no evidence of tracheal or bronchial obstruction and no pneumonia. The cause of death was thought to be generalized fibrinopurulent peritonitis.

The second case, W. M., was an 8-month-old boy, admitted to the hospital May 29, 1956. At 9:30 on the morning of admission, a barium enema had been performed by a technician at the physician's office. According to the mother, when the tube was first inserted and the balloon blown up, the child screamed and expelled the tube with the balloon inflated. The tube was re-inserted, the balloon inflated, and barium instilled. The baby again strained hard and expelled the tube and inflated balloon. The baby became pale and vomited. He was kept in the doctor's office until he looked a little better and then sent home. About five hours later, the mother brought the baby back because of restlessness, vomiting and abdominal distention. An x-ray was taken (Fig. 1), which revealed barium throughout the peritoneal cavity and a large amount of free air beneath the diaphragm. He was then taken to the hospital. A pediatrician saw the baby and called one of the authors (A. W. H.). This was approximately nine hours after the barium enema.

At that time, the baby felt cold and damp, skin was mottled and pulse rapid. The child was listless and fell asleep when not stimulated. The ab-

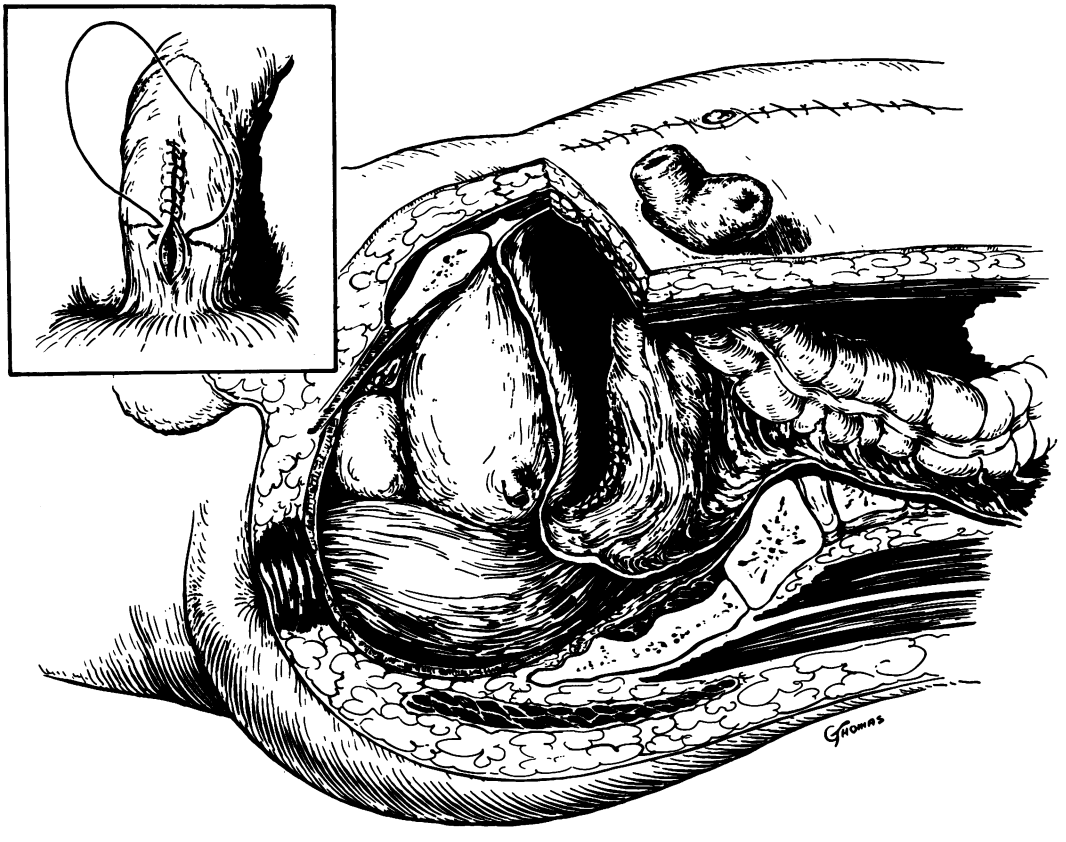

FIG. 3. Operation performed in case #2.

domen was distended and no bowel sounds could be heard. After intravenous injection of saline, the child appeared somewhat better and was taken to the operating room about 11 hours after the barium enema.

A long midline incision beginning at the symphysis pubis was made. A large amount of fluid and air rushed out on opening the peritoneum. The fluid contained barium, stool, and exudate. Much barium was stuck to the bowel, liver and peritoneum in gum like plaques. These were peeled off like tar from the skin following a tar burn. A large collection of fluid and air was found above the liver. The wide open peritoneal cavity was flushed with gallons of warm saline (Fig. 2). Fine adhesions were wiped away with the gloved hand and small localized collections were cleaned out where found.

Again, a longitudinal tear was found in the rectum beginning at the peritoneal reflection and extending proximally for 5 to 7 cm. This was closed with a running suture of 000 chromic and reinforced with interrupted fine cotton mattress sutures. A sigmoid loop colostomy was performed in the left lower quadrant through a separate incision (Fig. 3). The abdomen was closed with through and through wire stay sutures and in layers with interrupted cotton.

The infant appeared better at the end of the procedure than before or at any time during the operation. The credit for bringing this critically ill infant through such a procedure certainly belongs to the skilled anesthesiologist.

On admission, the blood count was only 2,800 white blood cells with 93 per cent lymphocytes. Seven days postoperatively, the count had risen to 24,000.

The child remained in critical condition for several days. The colostomy was opened on the second postoperative day. On the fourth postoperative day, he began having stool through the colostomy. On the 11th postoperative day his temperature became normal, and three days later he was discharged from the hospital (Fig. 4).

After going home, he developed pain and vomiting severe enough to require readmission to the hospital on two occasions. Both times, rapid recovery followed gastric suction, copious irriga-

tion of the colostomy, and intravenous fluids. Abdominal x-ray (Fig. 5) revealed residual barium but no evidence of obstruction.

It was six weeks postoperatively before the baby was back to normal, gaining weight, and eating well without distress. The mother had learned how properly to irrigate the colostomy. Irrigation was necessary until closure of the colostomy. On 22 October 1956, the colostomy was closed by resecting the exteriorized loop and performing an end to end anastomosis using two layers of interrupted fine cotton sutures. He was discharged on the fifth day after closure of the colostomy. He was having normal bowel movements and eating well.

By the 10th of November, 1956, the child's wound was well healed and he had reached a normal weight for an infant his age. He plays and reacts in a normal manner.

DISCUSSION

In reviewing the rather scanty literature on this subject, no other report of rupture of colon by barium enema in infants was found. Most of the reports concerned rupture of diseased colons.

Rupture of the normal colon, by pressure of the barium, seems most unlikely. Hamit [4] reported experimental work of Quenu (1882) showing that the intestine would bear a pressure of 50 to 60 cm. of mercury. All intestines would rupture with pressures over 70 cm. of mercury. Burt [3] found no section would support a pressure greater than 60 cm. of mercury, and that children under 12 years of age supported higher pressures than did adults. The case Hamit [4] reported was a pinpoint perforation in a patient with amebiasis.

Berk [1] reported a case of rupture of colon when a barium enema was done through a colostomy. The patient complained of pain as soon as the balloon on the catheter was blown up. X-ray did not show intraperitoneal barium, but laparotomy revealed a large perforation 4 cm. from colostomy.

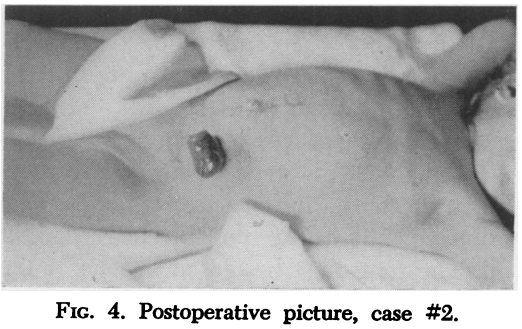

FIG. 4. Postoperative picture, case #2.

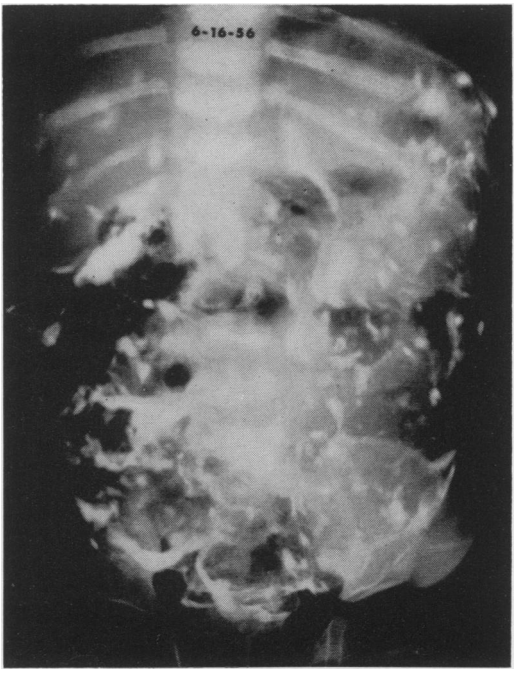

FIG. 5. Abdominal x-ray at time of re-admission because of pain and vomiting, case #2.

Kleinsasser and Warshaw [7] reported a ruptured colon in a patient with multiple diverticula. Here again the perforation was on the anterior surface of the sigmoid, just above peritoneal reflection, 4 cm. long and V-shaped.

An enema can, held at a height of three feet, exerts a pressure of 7.66 cm. of mercury pressure.[7] Twenty-one centimeters of mercury was the lowest necessary to rupture the bowel [7] and Best and Taylor [2] report a pressure of 20 cm. of mercury in process of defecation. To produce this pressure would require the enema can to be approximately eight feet above the patient.

It seems logical to assume that rupture occurs from distention of the balloon at a point where the bowel is more or less restricted in its ability to dilate by the peritoneal reflection (Fig. 6) or as in Berk's [1]

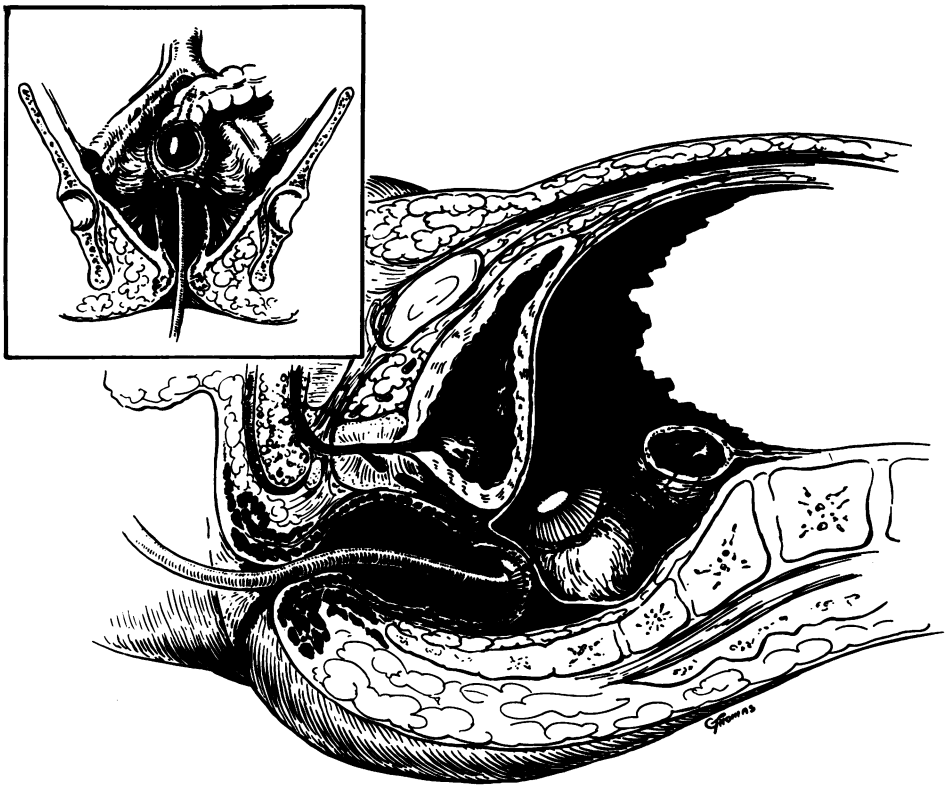

FIG. 6. Author's conception of mechanism of injury.

case, where dilatation of the colon is limited by its proximity to the peritoneal attachment. In Kleinsasser's [7] case, the perforation was near the peritoneal reflection, as well as in both these two reported cases. Serjeant and Raymond [9] report rupture in a similar place but state that it followed a barium meal and no barium enema was done. This seems difficult to understand unless the barium became impacted and severe straining at stool resulted in dilatation at the same fixed site, similar to that resulting from inflating a balloon at this point. In other reports [4, 5, 8] rupture occurred in diseased colons.

The mortality in traumatic rupture of colon is high. Hamit [4] reported 78 per cent mortality in 68 patients who had compressed air rupture of colon.

Of the eight cases reported of rupture of colon directly related to barium enema including the present two, three died, a mortality of 35 per cent. The cause of death is primarily generalized peritonitis. The offending agent must be a mixture of barium and contaminated stool. Kleinsasser [7] reported that barium alone and sterile stool alone injected into the peritoneum of dogs did not kill them. Barium with unsterile stool killed the dogs within 48 hours.

The treatment consists of prompt operation as soon as patient's general condition has been improved by the injection of saline and of blood when indicated. The operation should consist of wide exposure of the abdominal cavity with careful and adequate cleaning of all the spaces, using copious amounts of sterile warm saline. As much of the barium as possible should be removed, but it is impossible to remove it all. The rent must be closed by one of the acceptable methods and a proximal colos-

tomy established. It seems that if the perforation is low, a sigmoid colostomy is more advisable.

Accurate fluid balance, adequate antibiotics, and careful nursing care are essential to recovery after operation. In the fatality of the four-day-old infant, overloading with fluid as a factor cannot be entirely eliminated. Edema of the eyes developed a few hours before the first appearance of cyanosis and persisted until death six hours later.

Drainage does not seem advisable because of the absence of any localization and the inability to drain adequately the general peritoneal cavity. If any localized collections occur in the postoperative course they should be drained at an optimal time.

Gastric suction must be maintained until gas passes from the colostomy and bowel sounds are adequately audible. The colostomy should be opened in 24 to 48 hours after operation.

CONCLUSIONS

It is the opinion of the authors that rupture of the normal colon at the time of barium enema is due to over-distention of the balloon on the rectal catheter at a point where the colon is narrowed and fixed by the peritoneal reflexion. The balloon in the wide rectal ampulla could probably be fully inflated without injury.

This places great responsibility on the physician ordering a barium study of the colon to be sure that there is, first, an indication for such a study and, second, that adequate precautions to prevent this tragic complication are taken by those performing the study. When such an injury does occur, prompt operation, as described, is indicated.

BIBLIOGRAPHY

1. Berk, J. E.: Perforation Following Barium Enema. J. A. M. A., **148**: 766, 1952.
2. Best, C. H. and N. B. Taylor: Physiological Basis of Medical Practice, 4th edition. Williams and Wilkins Co., Baltimore, 1945.
3. Burt, C. A. V.: Pneumatic Rupture of Intestinal Canal. Arch. Surg., **22**: 875, 1931.
4. Hamit, H. F.: Perforation of the Colon after Barium Enema and Air Contrast Studies. Am. Surgeon, **21**: 1226, 1955.
5. Isaacs, I.: Intraperitoneal Escape of Barium Enema Fluid Perforation of Sigmoid Colon. J. A. M. A., **150**: 645, 1952.
6. Kaulich, L.: Perforation des Geschwurigen Dickdarmens Durch den Kontrasteinlauf. Med. Klin., **26**: 1042, 1930.
7. Kleinsasser, L. J. and H. Warshaw: Perforation of Sigmoid Colon During Barium Enema. Ann. Surg., **135**: 560, 1952.
8. Scheidt, R.: Darmperforation nach Kontrastdarstellung bei Stenosierendem Sigma-Carcinom. Chirurg., **21**: 602, 1950.
9. Serjeant, J. C. B. and J. A. Raymond: Perforation of Apparently Normal Colon after a Barium Meal. Lancet, **2**: 1245, 1952.

DISCUSSION.—DR. MARK M. RAVITCH, Baltimore, Md.: As I passed him on the way to the platform, Dr. H. W. Scott of Nashville wanted to know how large our series of ruptures was. It is zero, although we can add one of which a correspondent recently informed me in a suspected case of intussesception in which the barium was noticed in the peritoneal cavity almost at once. The baby was immediately operated upon, no intussusception was found, and a perforation in the rectosigmoid like those Dr. Hartman described was found and closed. I would be inclined to agree with his explanation that it is the balloon and not the pressure of the barium, because certainly in intussusceptions the barium probably is at a greater pressure. We use 3 to 3.5 feet of pressure without any manipulation. We are very careful just barely to introduce the balloon with the fingers, and then inflate it as indicated. We do this ourselves rather than turning it over to anyone else. In some 70 intussusceptions and in perhaps an equal number of children suspected by the pediatricians of having intussusception, and given diagnostic barium enemas, we have not seen this accident.

DR. ALBERT W. HARTMAN, San Antonio, Texas (closing): I have nothing to add, and I want to thank Dr. Ravitch for his discussion.