

after deep femoral angioplasty in 65% of patients, whereas among the "failure" group a similar increase in flow was achieved in only 12%. This is significant at the 10% level using the χ^2 test and applying Yate's correction.

We hope to find that measuring the flow in the deep femoral artery will provide another guide in deciding on the right operation. For example, if there were little atheroma and a high flow in the femoral artery and the run-off was good we would perform a bypass graft. If the run-off were bad and gangrene present amputation would be indicated or if there were pain at rest a sympathectomy. If the flow in the deep femoral artery were low a deep femoral angioplasty would be performed, unless both run-off and the quality of the saphenous vein were excellent. In that case a combination of bypass vein graft and angioplasty of the deep femoral artery would be preferable.

This tentative scheme, which we have adopted, will be the subject of a later report. All we can say so far is that extended deep femoral angioplasty will achieve a highly significant degree of success when bypass grafting is impossible or has

failed. We are exploring further the indications for extended deep femoral angioplasty vis-à-vis bypass vein grafting.

References

- ¹ Oudot, J., and Cormier, J. M., *Presse Médicale*, 1953, 61, 1361.
- ² Leeds, F. H., and Gilfillan, R. S., *Archives of Surgery*, 1961, 82, 25.
- ³ Morris, G. C., Edwards, W. S., Cooley, D. A., Crawford, E. S., and De Bakey, M. E., *Surgery*, 1961, 82, 32.
- ⁴ Vink, M., and Terpstra, J. L., *Journal of Cardiovascular Surgery*, 1963, 4, 366.
- ⁵ Waibel, P. P., *Journal of Cardiovascular Surgery*, 1966, 7, 179.
- ⁶ Martin, P., Renwick, S., and Stephenson, C., *British Journal of Surgery*, 1968, 55, 539.
- ⁷ Martin, P., Frawley, J. E., Barabas, A. P., and Rosengarten, D. S., *Surgery*, 1972, 71, 182.
- ⁸ Lindblom, A., *Acta Radiologica*, 1950, Suppl. No. 80, p. 55.
- ⁹ Margulis, A. R., Nice, C. M., and Murphy, T. O., *American Journal of Roentgenology, Radium Therapy, and Nuclear Medicine*, 1957, 78, 273.
- ¹⁰ Graziano, J. L., Olander, G. A., and Lal, R. B., *American Surgeon*, 1969, 35, 229.
- ¹¹ Cormier, J. M., and Dumas, J., *Journal de Chirurgie*, 1967, 93, 411.
- ¹² Beales, J. S. M., et al., *British Journal of Radiology*, 1971, 44, 854.
- ¹³ Cotton, L. T., Roberts, V. C., and Cave, F. D., in *Blood Flow Measurement*, ed. V. C. Roberts. London, Sector Publishing, 1972.

Large-bowel Perforations in Patients Undergoing Sigmoidoscopy and Barium Enema

J. F. FIELDING, K. LUMSDEN

British Medical Journal, 1973, 1, 471-473

Summary

Perforation of the large bowel can occur as a complication of sigmoidoscopy, rectal or sigmoid biopsy, and even of a simple cleansing enema. If the perforation is extraperitoneal there may be no early symptoms and consequently there may be delay in diagnosis. The risk of perforation during these procedures is small but it should not be ignored. The performance of a barium enema shortly after a rectal or sigmoid biopsy may slightly increase the risk by converting a partial perforation into a complete one. Precautions can be taken to minimize the hazard.

Introduction

Sigmoidoscopy, rectal biopsy, and the barium enema examination are so widely used in the investigation of disease of the large bowel, and there have been so few reports of serious complications arising from their use, that these procedures are apt to be regarded as virtually free from hazard. Each of them, however, can give rise to a perforation of the wall of the bowel, even when it is healthy, and we believe this risk should not be ignored.

In the present paper we report, as examples, some of our own cases in which the bowel was perforated in patients undergoing these investigations, and some other cases of which we have personal knowledge. We also discuss some technical details to which we think attention should be given in order that the risks of damaging the bowel may be minimized.

Perforation during Cleansing Enema

It is common knowledge that introduction into the rectum of a hard object such as the nozzle of a Higginson's syringe can

injure the bowel. It is perhaps not so well known that the rectal wall, even in the absence of disease, can be perforated by the tip of a rubber catheter introduced for the purpose of administering a simple cleansing enema. This may happen if a relatively inflexible catheter is introduced in such a way that its tip impinges heavily on the anterior wall of the rectum.

A large-bowel perforation during the administration of a simple enema can also occur at a site which precludes injury by the catheter as the cause. In that event the perforation occurs at some point where the bowel is diseased and the presumptive cause is a rise in the intraluminal pressure, perhaps brought about by an active contraction of the bowel. We know of one such case in which the perforation occurred in the caecum where there was an unusual lesion—a localized area of gangrene.

In the following case the catheter used for a cleansing enema may have injured the bowel.

Case 1.—An 84-year-old woman suffering from constipation was found to have a palpable and tender descending colon. In preparation for a barium enema examination a saline enema was administered by gravity feed through a funnel and tube and a No. 14 F.G. soft-tipped rubber catheter was used. The entire procedure was uneventful, the patient made no complaint of pain, and all the enema fluid was apparently recovered. Six hours later the patient was in a state of shock, with distended abdomen and diminished bowel sounds. At laparotomy after the patient had been resuscitated, diverticular disease of the descending colon and sigmoid were found and there was a perforation in the lower sigmoid.

Perforation due to Sigmoidoscopy

Perforation of the bowel can be caused by unskilled insertion of the sigmoidoscope; by attempting to force the instrument past an organic stricture or persistent area of spasm¹; and also by the sudden movement of a nervous patient during the examination, as the following case indicates.

Case 2.—A 45-year-old woman gave a two-year history of episodes of colicky lower abdominal pain and diarrhoea. Sigmoidoscopy was performed on a sigmoidoscopy table, with the patient tilted head downwards at an angle of about 60° from the horizontal.

Radcliffe Infirmary, Oxford OX2 6HE

J. F. FIELDING, M.D., M.R.C.P., Senior Medical Registrar
K. LUMSDEN, M.B., D.M.R.E., Consultant Radiologist

The sigmoid appeared hyperactive and while air was being pumped into it the patient suddenly raised herself and insisted on the examination being terminated. She was in discomfort but this soon began to subside and she was allowed to return home after she had dressed. Before reaching home she noticed that she was losing blood from her rectum and this led to her being admitted to hospital, where she was found to be shocked and given a blood transfusion. At laparotomy a 4-cm tear was found in the sigmoid.

Perforation from Rectal and Sigmoid Biopsy

Thorbjarnarson² reported five cases in which either sigmoidoscopic biopsy or removal of a polyp through the sigmoidoscope resulted in a perforation. He pointed out that the bowel can be perforated by taking too deep a bite with biopsy forceps from a sessile lesion, by biopsy of an ulcer which has caused thinning of the bowel wall, and by pulling a polyp too far down before removing it with a snare. It is hardly surprising that an area of pathological bowel should sometimes be perforated in this way; but perforation of a normal bowel can also be caused by a deep biopsy.¹

Whether the perforation due to a biopsy is intraperitoneal or extraperitoneal depends on the site from which the biopsy specimen is taken. In the following case there was an intraperitoneal perforation.

Case 3.—A man aged 79 years who was known to have diverticular disease of the colon complained of a recent increase in the severity of his symptoms. On sigmoidoscopy a small polyp was seen near the orifice of a diverticulum and a biopsy specimen was taken from it. The endoscopist was not aware of any serious injury to the bowel and the patient made no complaint during the examination. Some nine hours later, however, there were symptoms and signs suggesting that a perforation had occurred. This was confirmed by laparotomy. The colon appeared to be paper-thin and there was a perforation in it at what was believed to be the site of the biopsy. The polyp was benign.

Perforation as a Complication of Barium Enema

When a radiologist who is performing a barium enema examination sees evidence of leakage of barium out of the lumen of the bowel, he has several possibilities to consider. Barium may have entered an abscess cavity; it may have passed through a fistula into some other viscus; or it may have leaked through a recent perforation in the bowel wall. If he thinks it likely that there is a recent perforation he may have to consider whether this has been caused by a cleansing enema, sigmoidoscopy, rectal biopsy, or the barium enema itself.

Assuming that there had been no preceding endoscopic examination and that the performance of the barium enema was responsible, damage to the bowel might have occurred in one of three possible ways. Firstly, the bowel might have been injured by the catheter or tube used for giving the enema, in the same way as can happen when a cleansing enema is given. Secondly, if an inflatable balloon catheter has been used, injury might have been caused by over-inflation of the balloon. Among 13 patients reported by Seaman and Wells¹ with colonic rupture as a complication of a barium enema, there were six in whom over-inflation of a balloon catheter was regarded as a possible cause, though only one was an adult in whom the injury could be attributed to the inflation of a balloon in the rectum. Of the remaining five, three were infants and two were patients to whom enemas were given through colostomies. In another report four deaths in elderly patients were attributed to the use of this kind of catheter.³

The third possibility is that the rupture was due to an excessive rise in the intraluminal pressure. We have already referred to a case in which this appeared to be the cause of

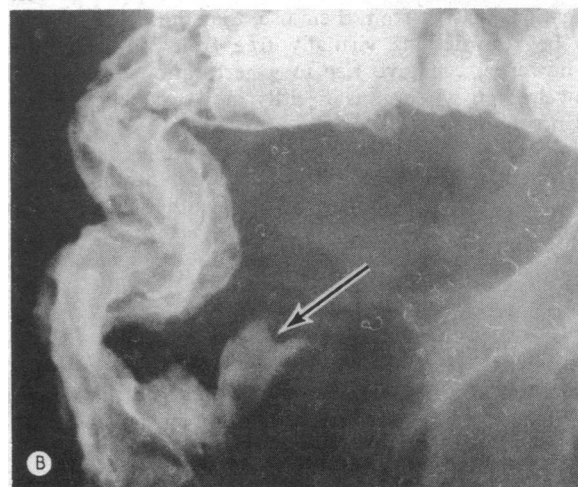
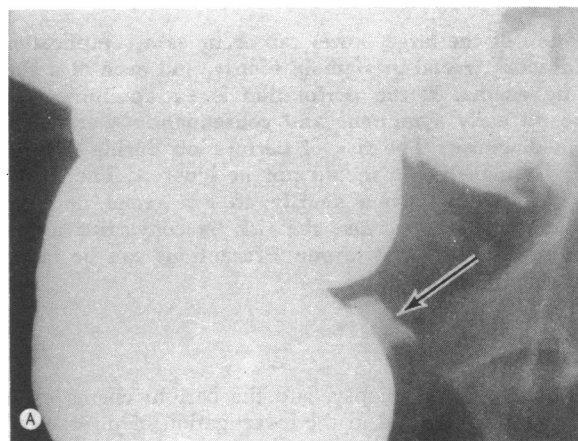
rupture during the administration of a cleansing enema, and there can be no doubt that a barium enema can have the same complication.

In the following case the administration of a cleansing enema might possibly have injured the bowel but the apparent cause of the perforation was the insertion of a rubber catheter as a preliminary step in the performance of a barium enema.

Case 4.—A woman aged 47 years was referred for a barium enema examination after an episode of rectal bleeding which had lasted for a few days and then spontaneously stopped. A soap and water cleansing enema was given by a nurse in the x-ray department and this caused no discomfort to the patient and no rectal bleeding. Afterwards the patient was placed on the x-ray table and a No. 14 F.G. rubber catheter was inserted into her rectum without difficulty and without causing her pain. Barium was introduced by gravity from a can, and because of the appearance shown on the television monitor the radiologist suspected that the barium was outside the bowel and immediately discontinued the examination. Sigmoidoscopy showed a small tear in the anterior wall of an otherwise healthy rectum. Although the amount of barium which entered the perirectal tissues was great, she made a good recovery with conservative treatment which included oral prednisone for three months.

Barium Enema after Biopsy

Hemley and Kanick⁴ reported two cases of rectal perforation as a result of rectal biopsy followed by barium enema. Sigmoidoscopy and biopsy were performed in one of their



Barium enema examination two hours after sigmoidoscopy with biopsy, showing a low perirectal leak (arrowed) in the filled phase (A), and after evacuation (B).

patients on the same day as the enema, and in the other two days earlier. In both patients the perforation was below the peritoneal reflection and barium was extravasated into the perirectal tissues. Both were treated conservatively and both died from peritonitis.

We have taken part in the investigation of thousands of patients for evidence of large-bowel disease, and in recent years a large proportion of these patients have had, on the same day, first a cleansing enema, then a sigmoidoscopy (and often a biopsy as well), and lastly a barium enema. All but a few of those subjected to this rapid sequence of procedures have been free from any complication, and the barium enema has shown no sign of the bowel having been injured by the preceding instrumentation. The exceptions were 10 patients in whom the x-ray examination showed an extravasation of barium into the perirectal tissues. In six of these the amount of extravasated barium was very small (see fig.), there were no associated symptoms, and no treatment was required. In the other four a larger quantity of enema fluid, together with gas, escaped from the bowel, and pain was experienced either immediately or after an interval varying from a few minutes to several hours. Three of these patients underwent an exploratory operation and were provided with a temporary colostomy and one was treated conservatively. There were no deaths and there has been no significant morbidity.

Discussion

As so many patients undergo sigmoidoscopy, rectal biopsy, and barium enema examination without developing any complication, the chances of perforating the bowel in these procedures are certainly small. Nevertheless it seems clear that perforations occur often enough to warrant consideration of ways of minimizing the risks.

In the performance of sigmoidoscopy the patient should be reassured and optimally positioned in the position of choice of the sigmoidoscopist. It is important that once the instrument has passed through the anal canal its further advancement should be in a posterior direction towards the patient's sacrum, the reason being that the long axis of the lower rectum is set approximately at a right angle to the direction of the anal canal. The instrument should be advanced only under direct vision and insufflated air should be kept to a minimum. It is also necessary to avoid the use of undue force if the instrument encounters resistance, due either to spasm of the bowel or to organic disease—for example, a stricture. If a biopsy specimen is taken, the site must be subsequently visualized to determine the depth of the tissue removed.

It has long been customary for rubber catheters to be used for giving cleansing enemas, and although, as we have seen, there is the possibility of even the healthy rectum being injured by these catheters, we do not recommend that their use be discontinued. But we believe that in the event of the catheter meeting with resistance when it is being inserted, it should be retracted a short distance, say 2 cm, rotated through an angle of 60° to 90°, and then gently advanced once more. If this simple manoeuvre is not immediately successful, it may be repeated. Alternatively, the nurse who is administering the enema may try the effect of running enema fluid through the catheter; this often causes enough rectal distension to allow the catheter to be introduced further into the rectum with ease.

For barium enemas, the type of rectal tube we prefer is a disposable one made of flexible plastic material with a bulbous tip, which is located in the lower rectum just above the anal canal when the tube has been correctly inserted. We know of no case in which a tube of this type has injured the bowel; and provided the enema is given slowly from a reservoir adjusted so as to deliver its contents by gravity at a low

head of pressure, it is seldom necessary to resort to the use of a balloon catheter.

In those cases in which, because of incompetence of the anal sphincter or for some other reason, the use of a balloon catheter seems unavoidable, certain precautions should be taken.⁵ Some of the more important ones are: rectal disease should have been excluded by a sigmoidoscopy; some barium should be run into the bowel before the balloon catheter is inflated; and if the patient cannot retain the enema, the balloon should be inflated under fluoroscopic control. Also, the balloon should be in the lower rectum, with only the bulbous tip of the rectal tube projecting into the lumen beyond, and it should never be over-inflated. The use of balloon catheters in infants is not only dangerous but unnecessary; and if this type of catheter is used for giving an enema through a colostomy, the inflated balloon should not be inside the colon but outside it and held against the colostomy opening, preferably by the patient himself.

Some authors have recommended that after a rectal or sigmoid biopsy the performance of a barium enema should be delayed for at least seven days⁵ or 14 days.⁴ The basis for such a recommendation is the belief that the rise in intraluminal pressure resulting from the enema may convert a partial perforation of the bowel into a complete one. Our own experience of large numbers of patients who have had barium enemas, some preceded on the same day by a biopsy, and some without any earlier instrumentation, has led us to believe that the former may have been exposed to a greater risk of extraperitoneal extravasation of barium than the latter. At the same time we believe that any difference in the risks between the two groups is a very small one.

If this view is correct, it follows that it is desirable, but not of paramount importance, that after the patient has had a biopsy of the rectum or sigmoid there should be a lapse of a week or two before he has a barium enema. It also follows that in those cases in which it is thought justifiable to perform a biopsy followed by a barium enema on the same day, the radiologist should know that the patient has had a biopsy, and its site, and in making his examination should pay special attention to the condition of the rectum and sigmoid before proceeding to study other parts of the bowel. He should also, in our opinion, refrain from carrying out air insufflation. A number of cases have been reported of retroperitoneal and interstitial emphysema as a complication of a barium enema, and it seems likely that the most common cause is the performance of a double contrast examination when there is rectal damage.⁶

Our own practice, if we decide to perform a barium enema on a patient who has recently had a sigmoidoscopy, whether or not there has been a biopsy as well, is to take a plain x-ray picture of the abdomen in order to look for possible evidence of retroperitoneal gas before starting the enema. In the event of this being shown the enema would be deferred; but in the absence of such evidence we proceed cautiously with the enema, using a flexible plastic tube with a bulbous tip such as we have already described, and suspending the plastic bag which contains the enema fluid at a low enough level to ensure a very slow rate of delivery of the barium into the rectum.

We believe that attention to the precautions we have outlined should still further reduce the risks to patients undergoing sigmoidoscopic and barium enema examinations, irrespective of the temporal relationship of these examinations.

References

- ¹ Seaman, W. B., and Wells, J., *Gastroenterology*, 1965, 48, 728.
- ² Thorbjarnarson, B., *Archives of Surgery*, 1965, 84, 608.
- ³ Ansell, G., *Clinical Radiology*, 1968, 19, 175.
- ⁴ Henley, S. D., and Kanick, V., *American Journal of Digestive Diseases*, 1963, 8, 882.
- ⁵ Margulis, A. R., *Alimentary Tract Radiology*, vol. 2, ed. A. R. Margulis and H. J. Burhenne. Saint Louis, Mosby, 1967.
- ⁶ Brunton, F. J., *Clinical Radiology*, 1960, 11, 197.