

# Colorectal Carcinoma Missed on Double Contrast Barium Enema Study: A Problem in Perception

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A total of 31 cases of primary colorectal carcinoma missed on double contrast barium enema studies over a 5 year period (1976–1980) were collected from six institutions, and the causes of error reviewed. The errors were purely perceptive in 52%, due to a combination of perceptive and technical factors in 32%, and interpretative in 6%. The most common perceptive mistakes were failure to recognize a filling defect in the barium pool and failure to detect the tumor en face in double contrast study. Five cases were only detected at the time of the study as a result of double reading. Ten percent of the lesions could not be seen in retrospect, and therefore can be attributed to failure of the technique itself. At four of the institutions, the double contrast barium enema study missed 11 (6%) of 197 primary colorectal carcinomas. The lesion was invisible in retrospect in only two (1%) of these 197 studies, indicating that the double contrast examination is potentially highly sensitive for detecting colorectal carcinoma. The mainly perceptive nature of the errors indicates the need for more careful viewing of double contrast barium enemas. Familiarity with the different appearances of colorectal carcinoma on double contrast study, together with double-reading by the same or different observers, should reduce the incidence of missed lesions.

The double contrast barium enema study is being used with increasing frequency in the radiologic evaluation of the colon. Carcinoma of the large bowel is the second most common malignancy in the USA [1]. It is important to appreciate the appearances produced by colorectal carcinoma on double contrast examination as these can differ considerably from those seen on a conventional study, and even large carcinomas are occasionally missed. The recent series by Ott et al. [2] is the only one of which we are aware that reviews in detail the reasons for missed lesions on double contrast barium enema studies, but it does not contain any carcinomas missed with this technique. Our report reviews the causes of error in 31 patients in whom a carcinoma of the colon or rectum was missed on double contrast study. Its purpose is to analyze the reasons for such errors and make suggestions to help reduce their incidence.

## Materials and Methods

We collected 31 double contrast barium enema studies from six institutions performed over a 5 year period (1976–1980) in which a primary colorectal carcinoma had been missed. Of the 31 studies, 21 were carried out at university medical centers, although many of these examinations were not performed or interpreted by radiologists with a special interest in gastrointestinal disease. The other 10 studies were performed at three neighboring nonuniversity hospitals. The cases were obtained from the records of the pathology departments or as a result of being brought to the attention of one of the authors. The only criterion for inclusion in the study was that the subsequent diagnosis of carcinoma had to be made and confirmed by histologic examination within 3 years after the barium enema study. Patients with polypoid lesions found to represent carcinoma in situ were excluded.

The double contrast barium enema studies on which the carcinoma had been missed

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were reviewed in conjunction with information from the patient's chart stating the location of the subsequently recognized lesion. The location and size of the carcinoma were noted, as was the presence of diverticula, stool, and any synchronous malignancy. The barium enema studies were divided into two groups depending on whether or not the lesion was visible in retrospect. Lesions not seen in retrospect were regarded as purely technical errors. Lesions visible in retrospect, that is, perceptive errors, were further divided into three groups slightly modified from those used by Ott et al. [2]: (1) purely perceptive error—any technical deficiencies of examination were not thought to contribute to the error; (2) perceptive and technical error—technical inadequacy was thought to be contributory; or (3) interpretative error—lesion observed at time of study but carcinoma not included in differential diagnosis. The perceptive and technical errors were then analyzed by reviewing the examinations to determine the radiographic appearance of the lesions missed at the time of study and the specific technical inadequacies.

The charts of the 31 patients were reviewed to determine the method by which the carcinoma was subsequently detected and the length of delay in diagnosis as a result of the lesion being missed by barium enema study. The stage of the carcinoma based on the Duke classification was also noted.

## Results

The missed carcinomas were located in the sigmoid colon (nine cases), ascending colon (eight), rectum (five), cecum (three), transverse colon (three), and descending colon (three). Of the 31 lesions, 27 were polypoid masses and four were strictures. The size of the lesions was 1.5–9 cm (mean, 3 cm). In four cases diverticula were present in the immediate vicinity of the carcinoma and were thought to have contributed to the error. No examination showed stool in the region of the carcinoma, and in all cases stool was virtually absent from the rest of the colon. There were two cases of synchronous carcinomas, and in both of these one of two lesions was overlooked.

The categories of error in the 31 patients are presented in table 1. Twenty-eight of the carcinomas were visible in retrospect; 16 of the errors were purely perceptive, 10 were due to a combination of perceptive and technical factors, and two were interpretative. In three examinations, the lesion could not be seen in retrospect. The specific causes of the errors in those examinations in which the lesion was visible in retrospect are shown in table 2.

The diagnosis of carcinoma of the colon was subsequently made by barium enema study in 13 patients, by colonoscopy in seven, and by sigmoidoscopy in six. In five patients the diagnosis was made at the time of the initial double contrast barium enema study, but only as a result of the examination being double-read by a second radiologist with a special interest in gastrointestinal disease. The delay in diagnosis (except for the cases submitted to double-reading) ranged from 2 days to 2.5 years (mean, 7 months). In 11 of the 31 patients the delay was greater than 6 months. Data were available on the Duke classification in 25 of the patients. There were four patients with stage A disease, 16 with stage B, three with stage C, and two with stage D.

For four of the six institutions, the total number of patients with biopsy-proven primary colorectal carcinoma diagnosed

**TABLE 1: Categories of Error in Patients with Missed Colorectal Carcinoma**

Retrospective Finding/Type of Error	No. Patients (%)
<b>Lesion visible:</b>	
Purely perceptive	16 (51.6)
Perceptive + technical	10 (32.3)
Interpretive	2 (6.4)
Subtotal	28 (90.3)
<b>Lesion invisible:</b>	
Overlapping loops	1 (3.2)
Poor coating	1 (3.2)
Examination appeared adequate	1 (3.2)
Subtotal	3 (9.7)
<b>Total</b>	<b>31 (100.0)</b>

**TABLE 2: Specific Causes of Error in 28 Patients in Whom Lesion Was Visible in Retrospect**

Type of Error	No. Errors
<b>Perceptive*:</b>	
Filling defect in barium pool missed	12
Mucosal surface of tumor en face missed	6
Soft-tissue mass of tumor missed	4
Contour defect due to tumor missed	3
Ulceration due to tumor missed	1
Subtotal	26
<b>Technical†:</b>	
Excessive, undrained, barium around lesion	4
Poor distension of lumen	4
Poor coating of lesion	3
Overexposed film of lesion	3
Lesion obscured by ileal reflux	1
Subtotal	15
<b>Interpretive:</b>	
Mistaken for benign stricture in ulcerative colitis	1
Mistaken for large internal hemorrhoid	1
Subtotal	2
<b>Total</b>	<b>43</b>

\* Comprised 16 purely perceptive lesions and 10 partly perceptive lesions.  
 † In some cases more than one technical error was present.

between January 1977 and December 1979 was determined from the records of the departments of pathology. There were 285 patients, of whom 197 had been examined by double contrast barium enema study within a 3 year period prior to diagnosis. The double contrast study missed the carcinoma in 11 (6%) of the 197 patients. Nine of these 11 carcinomas were visible in retrospect.

## Discussion

Most colorectal carcinomas are slow growing neoplasms [3, 4]. This forms the basis for our assumption that if a carcinoma is found within 3 years of a previously "normal" barium enema study, the tumor was missed [5]. Application of this criterion to double contrast barium enema studies at six institutions enabled us to review a relatively large number

of colorectal carcinomas missed with this technique. About one-half of the 31 lesions were missed due to a purely perceptive error, and in a further one-third a combination of perceptive and technical factors were considered responsible (table 1). These findings are similar to those observed by Ott et al. [2] whose study included 11 polyps missed with the double contrast barium enema study. Most of the lesions visible in retrospect in our series were obvious but in a few patients they were subtle (fig. 1).

By far the most common perceptive error was failure to recognize a filling defect in the barium pool (figs. 2-4). In their account of the principles of double contrast diagnosis, Kressel and Laufer [6] pointed out that the barium pool can reveal or cover up a protruding mass on the dependent wall of the bowel (fig. 5) as well as obscure one on the nondependent surface. It is clear from our data that insufficient attention was paid to evaluating the barium pool for filling defects, possibly because the radiologist was overly interested in those parts of the colon shown in double contrast study. As a general rule the margin of a barium pool is convex outwards, and any concavity of the margin (i.e., a filling defect) is highly suspicious of a mass whether due to a neoplasm or stool (fig. 4).

Failure to recognize the mucosal surface of a carcinoma seen en face (fig. 6) constituted the second most frequent perceptive error. Many lesions on double contrast radiography are only demonstrated en face, so that if reliance for detecting a carcinoma is placed on evidence of a contour

defect this will result in an appreciable number of missed lesions. In this series, only three of the 26 carcinomas included in the category of perceptive errors showed a contour defect. Evidence of a carcinoma en face on double contrast radiography can be quite subtle when the lesion is only slightly elevated or the tumor-mucosal interface is gently sloping, as under these circumstances only a linear shadow may be produced [7].

Technical deficiencies contributed to about one-third of the perceptive errors (table 1), and in some of the examinations these were multiple. Failure to drain sufficient barium to reveal the lesion clearly was noted to occur particularly in the rectum (fig. 5). Rectal drainage may be accomplished by elevating the head of the table with the patient prone, and introducing enough air to force barium downward out of the rectum and into the enema bag [8]. Three cases of carcinoma were missed due to overexposed radiographs. It is likely that careful examination of such radiographs with a bright light can often prevent this source of error. These three carcinomas were all located in the ascending colon and the decubitus views had been incorrectly exposed. The left decubitus view is particularly important because it alone may demonstrate virtually the entire right colon in double contrast. Poor distension of the lumen and poor mucosal coating (fig. 7) each contributed to several missed carcinomas. Both of these deficiencies should be easily recognized and corrected at fluoroscopy. There were only three patients in whom the lesion could not be seen at

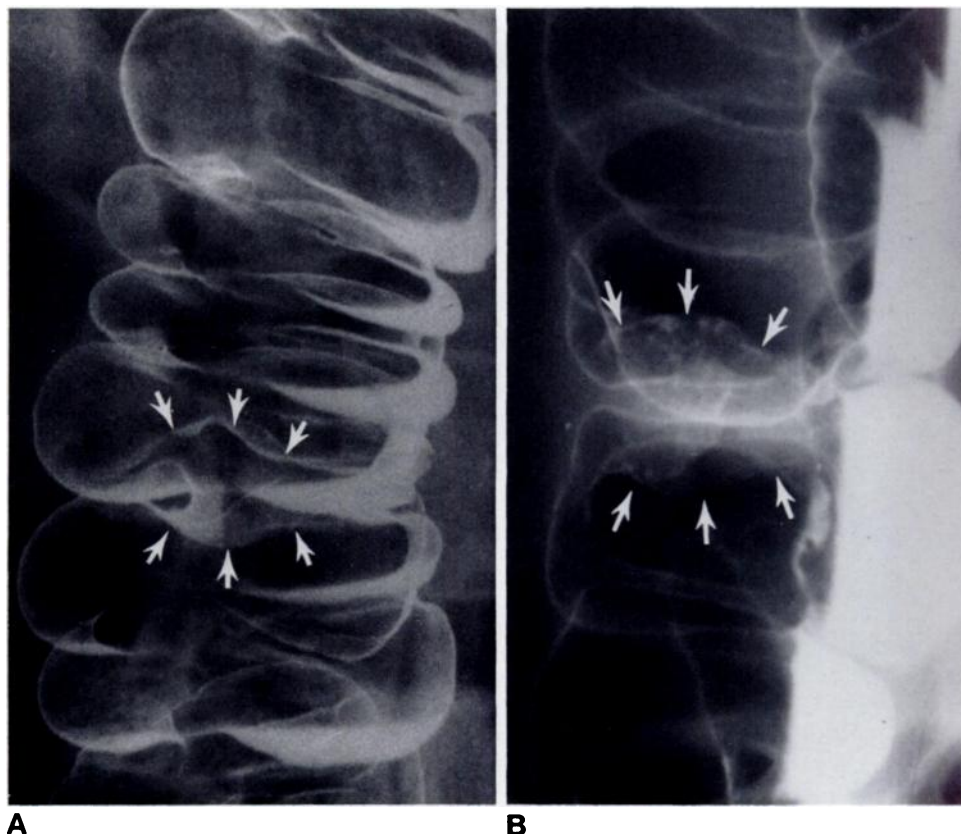


Fig. 1.—Carcinoma of ascending colon. **A**, Subtle evidence of mass with adjacent folds displaced away from each other (arrows). **B**, 1 year later. Mass is considerably larger and obvious (arrows).

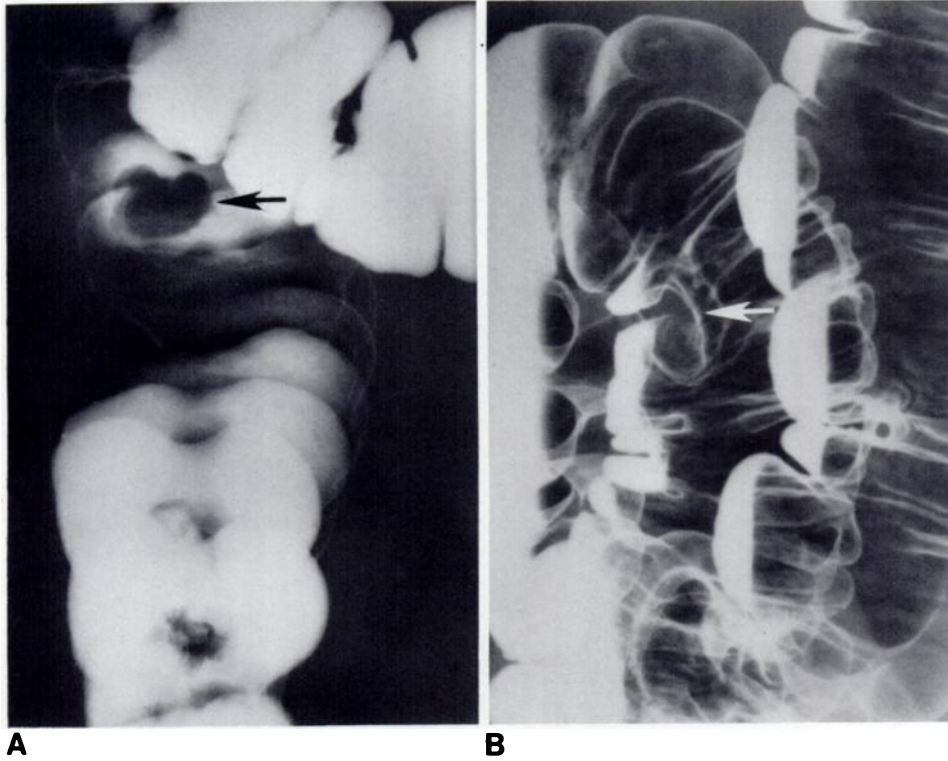


Fig. 2.—Carcinoma at hepatic flexure. **A**, 2.5 cm polypoid mass (arrow) in barium pool missed. **B**, 2 years later. Lesion (arrow) was recognized.

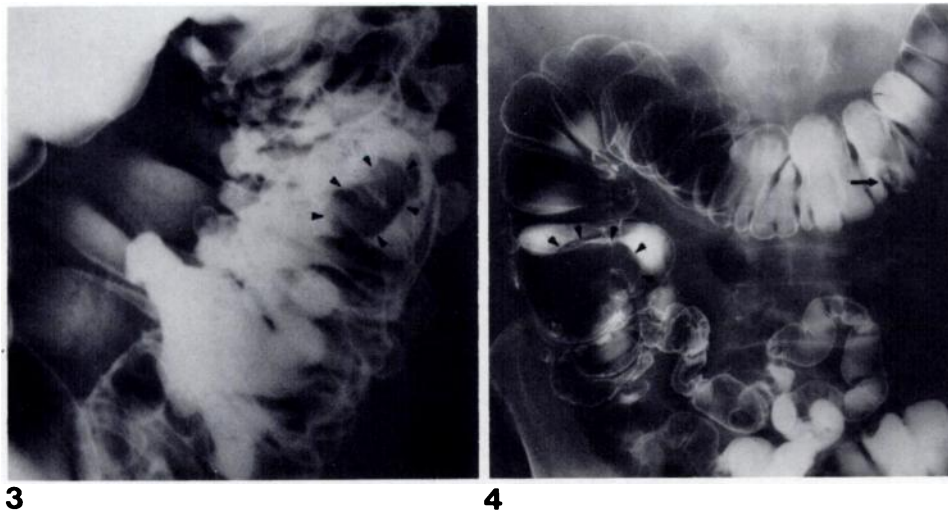


Fig. 3.—Severe diverticulosis and carcinoma in sigmoid colon. Polypoid carcinoma in barium pool (arrowheads) overlooked, probably because of distraction by severe diverticulosis.

Fig. 4.—Carcinoma of cecum. Polyp in transverse colon (arrow) observed but large carcinoma of cecum producing concavity of margin of barium pool (arrowheads) overlooked.

all in retrospect, and failure to demonstrate the lesion could therefore be regarded as purely technical (table 1).

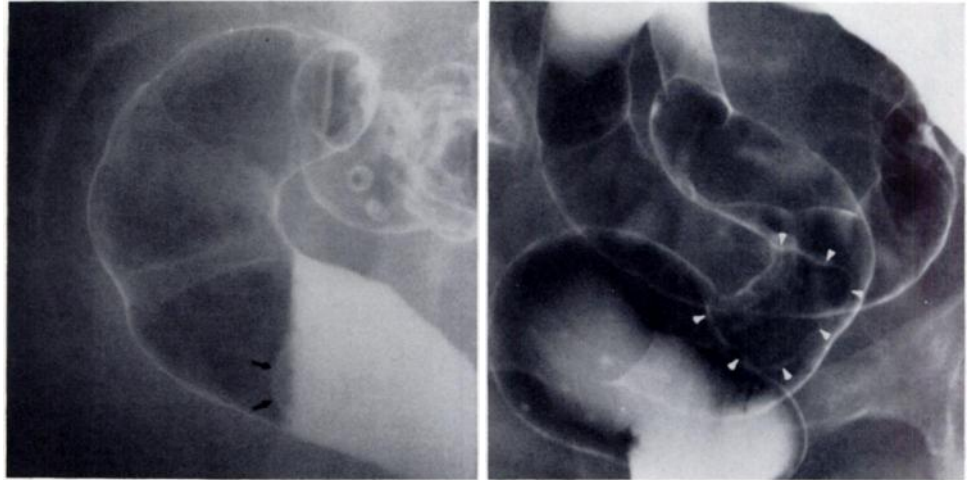
In two patients there were errors of interpretation. One had chronic ulcerative colitis and the double contrast examination showed a long smooth area of narrowing thought to represent a benign stricture (fig. 8). The ability of infiltrating carcinoma to mimic a benign stricture in ulcerative colitis is well recognized [9]. The other patient had a lobulated rectal mass misinterpreted as a large internal hemor-

rhoid. Although none of the examinations were marred by significant amounts of stool, it is possible that some of the lesions were misinterpreted as stool.

The presence of diverticula appeared to contribute to the missing of an adjacent carcinoma in four patients. One report documents that carcinoma was found twice as often in patients with diverticular disease as in those without this condition, but does not mention whether the carcinoma was located within the same segment of the colon as the diver-



Fig. 5.—Carcinoma of rectum (arrows) almost completely hidden by barium pool. Because of excessive, undrained barium, lesion not seen on other views.

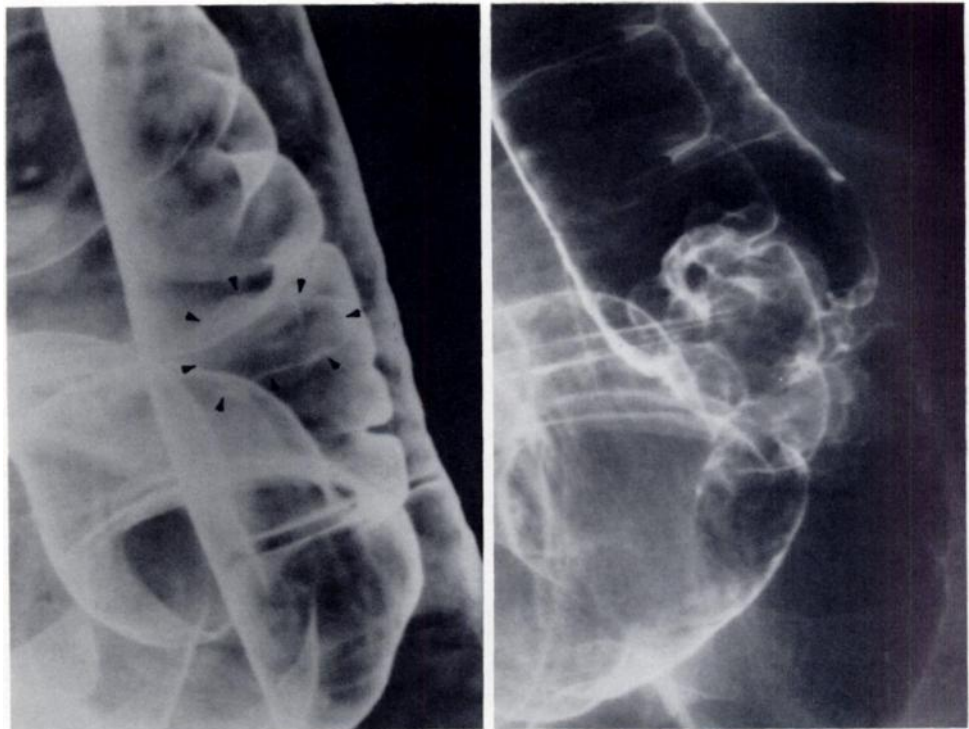


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6

Fig. 6.—Large carcinoma of rectosigmoid with mucosal surface of tumor seen en face (arrowheads). Bowel wall has normal margin.

Fig. 7.—Carcinoma of descending colon. A, Polypoid mass (arrowheads) poorly coated with barium. Flocculated barium in upper part of radiograph is further evidence of poor mucosal coating. B, 2 years later. Larger lobulated mass in same location clearly visible.



A

B

ticula [10]. None of our four patients had any pathologic evidence of diverticulitis. In two of these patients, the lumen of the colon in the area of diverticulosis was incompletely distended and administration of a smooth muscle relaxant such as glucagon (0.5 mg intravenously) might have been of diagnostic value. The other two patients had extensive diverticular disease close to the carcinoma, which may well have distracted the radiologist from perceiving the more significant lesion (fig. 3). Distraction probably also accounted for one of the two missed synchronous colon car-

cinomas, which was located in the cecum (fig. 9). Seaman [11] pointed out that a proximal synchronous carcinoma may also be missed because of the radiologist's reluctance to fill the colon above a distal carcinoma. High-grade obstruction by colorectal carcinoma is uncommon and the entire colon can therefore be safely examined in the vast majority of cases. Recent reports indicate that the incidence of synchronous carcinoma is as high as 5.5% [12]. Preoperative recognition is important because the surgeon may fail to palpate a second carcinoma at laparotomy. In one of

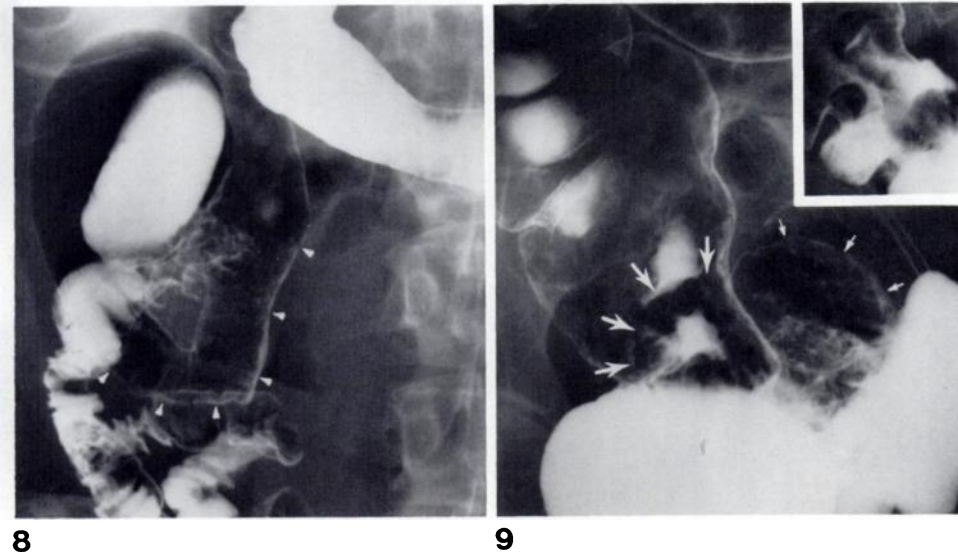


Fig. 8.—Carcinoma in chronic ulcerative colitis. Long smooth stricture (arrowheads indicate inferior margin) misinterpreted as benign lesion.

Fig. 9.—Synchronous carcinomas. Carcinoma of rectosigmoid (small arrows) recognized but carcinoma of cecum (large arrows) missed. Inset shows detail of ulcerating carcinoma to better effect.

our cases (not a synchronous colon carcinoma) a large cecal carcinoma was missed surgically as well as radiologically and endoscopically while a relatively small adenomatous polyp was recognized and removed (fig. 4). The association of carcinoma and benign polyps, as well as the possibility of synchronous carcinomas, highlights the importance of especially careful examination of the entire colon whenever one neoplastic lesion is found.

The regions where carcinomas were most frequently missed were the sigmoid (nine cases) and ascending (eight) colon. However, as in Hunt's [13] experience, carcinomas were missed throughout the colon. The distribution of polyps missed by double contrast examination appears to be different, with the vast majority of errors occurring in the sigmoid colon [2, 13]. Recent evidence shows that an increasing percentage of colon carcinomas are located in the ascending colon or cecum [12]. Careful radiologic assessment of the right colon is particularly important, as colonoscopists are not routinely successful in reaching this far.

Most missed carcinomas in this series were polypoid in configuration rather than annular lesions. It is well known that early carcinomas of the colon or rectum are usually polypoid [4, 14]. The relatively localized stage of invasion (Duke's A or B) of most of the carcinomas in our series further suggests that many of the cases were early carcinomas. Advanced carcinoma is much more likely if a contour defect is visible radiologically [15], a finding seen infrequently in our series. Delay in diagnosis exceeded 6 months in one-third of the cases, and the eventual diagnosis was subsequently established by repeat double contrast examination twice as often as by colonoscopy. In view of the well documented role of colonoscopy in patients with normal barium enema studies suspected of harboring colonic neoplasia [10, 13], it appears that colonoscopy was underutilized in this group of patients.

Of the missed carcinomas, 90% were visible in retrospect, indicating that the main cause of error is a perceptive one

and that the technique of double contrast examination itself is sensitive for detecting colorectal carcinoma. Its sensitivity is further suggested by the known error rate for four of the six hospitals of 11 (6%) of 197 cases. Only two of these 11 missed carcinomas were invisible in retrospect, giving the technique a potential sensitivity of 195 (99%) of 197 cases. Various technical deficiencies such as incomplete barium drainage, poor distension, and overexposed films contributed to the error in a significant number of cases, and are readily correctable. Improved sensitivity of the technique requires a more careful review of the radiographs in order to reduce the number of perceptive errors. Each of the radiographs must be carefully examined as a carcinoma is often visible only on one or two views. Five of the carcinomas in this series were recognized at the time of initial barium enema study only because the examination was double-read by a second observer. While double-reading is a luxury that would be difficult to institute on a widespread basis, it is quite feasible for the radiologist performing the study to analyze the radiographs both at the conclusion of the examination and subsequently, when the study is formally interpreted. Radiologists must become familiar with the principles of interpretation of lesions as seen on double contrast studies [6] if the full value of the technique is to be realized.

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