Original Report

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Usefulness of CT Colonography in Patients with Incomplete Colonoscopy

OBJECTIVE. Our objective was to investigate the use of CT colonography in patients who have undergone incomplete colonoscopy.

CONCLUSION. CT colonography is effective in evaluating portions of the colon not seen during colonoscopy and may have an adjunctive role.

Evidence exists that colorectal cancer, the second leading cause of cancer death in the United States [1], develops from precursor adenomatous polyps [2–4]. Screening techniques that may decrease the morbidity and mortality associated with colorectal cancer by revealing premalignant adenomatous polyps [2–4] include fecal occult blood testing, sigmoidoscopy, barium enema, and colonoscopy. Each method has advantages and disadvantages [5].

Complete fiberoptic colonoscopy provides the most thorough evaluation of the colon, with the added benefit of allowing biopsy of suggestive regions. However, expense, discomfort, a need for sedation, and a potential risk of perforation limit the widespread use of fiberoptic colonoscopy. In addition, in up to 10% of patients the complete colon is not shown [5, 6].

Double-contrast barium enema is usually performed to complete the colonic evaluation in these patients. However, the proximal colon may not be optimally evaluated with double-contrast barium enema immediately after colonoscopy because colonic distention with gas prevents adequate coating with barium.

A new technique to evaluate the luminal surface of the colorectum is CT colonography [7, 8]. Its advantages include rapid data acquisition and minimal patient discomfort, and preliminary data suggest a sensitivity in the detection of colorectal polyps similar to or better than that of double-contrast barium enema [9]. A recent report described the ability of CT colonography to show the colon proximal to occlusive cancer [7]. We report our initial experience with both CT colonography and double-contrast barium enema in finishing the colonic examination of patients for whom colonoscopy was incomplete.

Subjects and Methods

Between September 1997 and December 1998, 20 patients with incomplete colonoscopy examinations were immediately referred by the colonoscopists for CT colonography, specifically to evaluate the proximal bowel. Ten of these patients subsequently underwent double-contrast barium enema. These 10 patients are the focus of this report. They included four men and six women ranging from 50 to 80 years old (mean, 65 years). The indications for colonoscopy were screening (n = 8) and bleeding (n = 2). Patients underwent a standard bowel preparation beginning the day before the procedure with either polyethylene glycol electrolyte solution (GoLytely; Braintree Laboratories, Braintree, MA) and bisacodyl tablets or sodium phosphate (Prep Kits; C. B. Fleet, Lynchburg, VA). All patients gave informed consent.

CT was performed with HiSpeed Advantage scanners (General Electric Medical Systems, Milwaukee, WI). Helical images were acquired using a 5-mm slice width, a pitch of 2.0, a reconstruction interval of 2.5 mm, 120 kV, and 150 mA. One

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milligram of glucagon hydrochloride (Eli Lilly, Indianapolis, IN) was administered IV immediately before the examination to facilitate hypotonia. Supine and prone data sets were obtained from 2 cm above the splenic flexure through the rectum after insufflation of room air into the colon. The adequacy of colonic insufflation was determined from a scout image obtained before CT colonography. Patients were instructed to hold their breath during data acquisition. Each CT examination (supine and prone) required approximately 25–30 sec.

CT data were transferred to a remote Advantage Windows workstation (General Electric Medical Systems, Milwaukee, WI) equipped with Navigator software (General Electric Medical Systems), where two-dimensional and three-dimensional CT colonography was performed. Initially, axial CT images were evaluated. Then, multireformatted two-dimensional CT images and three-dimensional endoluminal CT colonography were simultaneously evaluated using threshold rendering. The threshold level was set at approximately –800 H but was adjusted to obtain optimal endoluminal renderings. Colonographic data were analyzed for absence or presence of abnormal filling defects. If a lesion was suspected, the area of interest was carefully evaluated on both the supine and the prone data sets.

Ten of the 20 patients who had CT colonography after incomplete colonoscopy underwent concurrent (i.e., immediately after CT) (n = 7) or subsequent (n = 3) double-contrast barium enema. The double-contrast barium enema study was requested for two patients by the colonographer to confirm suspected polyps identified on the CT colonography examination and for eight patients by the clinician to confirm the finding of no abnormalities on the CT colonography examination. For seven patients, the double-contrast barium enema was performed by the same person who interpreted the CT colonography examination. For three patients, a different gastrointestinal radiologist performed the barium enema. For all 10 patients, CT colonography was performed before double-contrast barium enema. We did not attempt to hide the results of either radiologic study from the observers or to formally assess whether each patient preferred CT colonography or double-contrast barium enema.

Results

Twenty patients were referred for CT colonography after incomplete colonoscopy. Ten were not examined further; their results were interpreted as normal. The remaining 10 underwent both CT colonography and double-contrast barium enema. Within this group, the colonoscopist visualized the colon to the level of the sigmoid colon (n = 1), mid transverse colon (n = 1), or hepatic flexure (n = 8), and the proximal colon was evaluated fully with CT colonography. In one patient, in whom colonoscopy was completed to the hepatic flexure, the sigmoid colon was partially collapsed despite supine and prone imaging. In another patient, a 5-mm polyp was removed from the sigmoid colon during colonoscopy.

Eight of 10 CT colonography examinations were judged to show normal findings on both the supine and the prone data sets. In these eight patients, subsequent double-contrast barium enema showed no polyps. In two

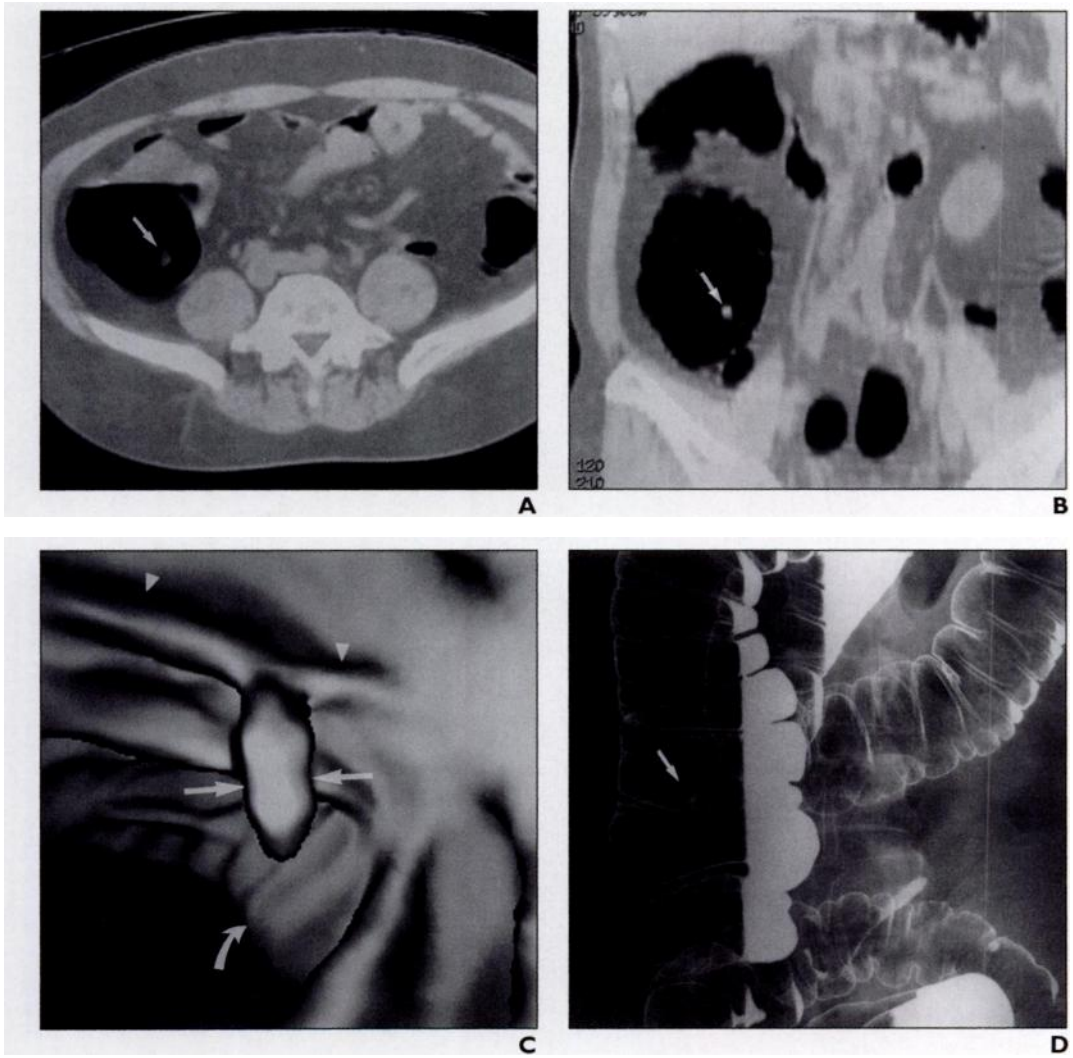

Fig. 1.—55-year-old man with colonoscopy completed to hepatic flexure.
A, Axial CT scan with patient prone reveals small polypoid mass (*arrow*) on posterior haustral fold in ascending colon.
B, Coronal two-dimensional reformatted CT scan shows 1-cm polyp (*arrow*) in ascending colon.
C, Three-dimensional endoluminal scan from distal to proximal ascending colon shows polyp (*straight arrows*) on haustral fold (*arrowheads*). Note ileocecal valve (*curved arrow*).
D, Radiograph obtained during double-contrast barium enema shows polyp (*arrow*) in ascending colon. Repeated colonoscopy (not shown) confirmed tubular adenoma.

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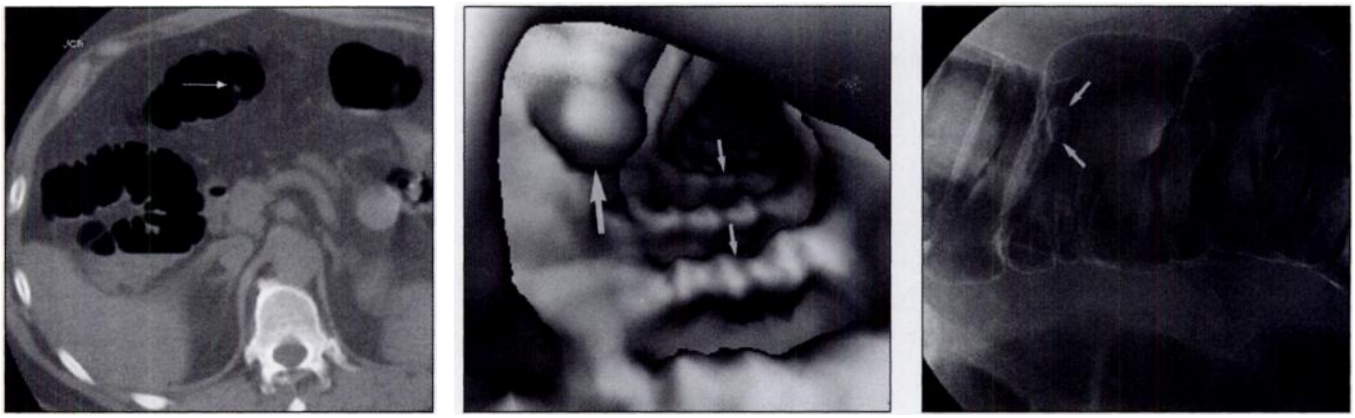

Fig. 2.—58-year-old man with colonoscopy completed to hepatic flexure.
A, Axial CT scan shows 7-mm polyp (*arrow*) in transverse colon.
B, Three-dimensional endoluminal scan shows same polyp (*large arrow*). Note haustral folds (*small arrows*).
C, Radiograph obtained during double-contrast barium enema shows polyp (*arrows*) in transverse colon. Patient was scheduled for follow-up colonoscopy in 6 months.

patients, solitary polypoid filling defects were seen on both the two-dimensional and the three-dimensional CT colonography images.

In the first patient, a 55-year-old man, colonoscopy was completed to the hepatic flexure. At CT colonography, a polypoid filling defect measuring 1 cm at the widest diameter was identified in the ascending colon, on the posterior wall just distal to the ileocecal valve (Figs. 1A–1C). This lesion was identified only on the prone CT images (it was obscured by retained fluid on the supine images) and was confirmed on a subsequent double-contrast barium enema (Fig. 1D). Follow-up colonoscopy and polypectomy confirmed the presence of tubular adenoma.

In the second patient, a 58-year-old man, colonoscopy was also completed to the hepatic flexure. At CT colonography, the proximal colon appeared normal. However, on the posterior wall of the mid transverse colon, a 7-mm polypoid lesion was identified (Figs. 2A and 2B). This had not been seen during colonoscopy. Because the CT colonography findings created a strong suspicion that a polyp was missed during colonoscopy, double-contrast barium enema was performed and confirmed that a polyp was in the mid transverse colon (Fig. 2C).

Discussion

Although the best strategy for colorectal cancer screening has not been firmly established, health care providers and policy makers have reached unanimous consensus on two basic principles: Screening patients for colorectal cancer is justified, and screening only with fecal occult blood testing and sigmoidoscopy is inadequate because at some point the entire colonic surface must be examined [5, 10, 11]. Colonoscopy has the advantages of allowing potentially complete evaluation of the colon and endoscopic removal of visualized polyps. The ability to evaluate the entire colon with colonoscopy depends on several factors, including the endoscopist's skill and the patient's tolerance of the procedure. However, failure to visualize the entire colonic surface occurs in 5–10% of colonoscopy examinations [5, 6]. In these instances, further evaluation is necessary.

Most protocols rely on double-contrast barium enema as the method of choice to complete the examination of patients for whom colonoscopy does not show the entire colon. If double-contrast barium enema is performed concurrently with colonoscopy, the patient need not undergo a second bowel preparation. However, in patients with redundant colons, retained gas from the endoscopic procedure may inhibit the smooth flow of barium, and proximal colonic evaluation may be limited either because the barium inadequately coats the colonic surface or because retained gas blocks the barium from the right colon. CT colonography is not limited in these situations.

Techniques for CT colonography vary from institution to institution [7–9]. Our protocols include evaluation of both two-dimensional axial CT images and three-dimensional endoluminal images as well as data acquisition with patients in both the supine and the prone positions. The combination of two-dimensional and three-dimensional CT colonography is used to increase confidence that a mucosal lesion is present through confirmation by an additional technique. In addition, by supplementing three-dimensional images with multireformatted two-dimensional data, the exact location of a lesion in the bowel can be determined. Borrowing on principles of double-contrast radiographic technique, use of supine and prone positioning provides the air–colon interface maximization (through redistribution of intraluminal fluid) that is necessary for complete mucosal evaluation (Fig. 1). Use of supine and prone technique helps insure optimal distention along the length of the bowel and may facilitate differentiation of stool from polyp by establishing that a finding stays consistent despite change in patient position [12].

CT colonography has several potential advantages over double-contrast barium enema in the setting of incomplete colonoscopy. After incomplete colonoscopy, the colon is frequently distended with gas, which may impede an optimal double-contrast barium enema. Because distention of the colon is necessary for effective CT colonography, little additional air insufflation is required after incomplete colonoscopy, making CT colonography technically easy in this setting. In addition, after incomplete colonoscopy, CT colonography will likely be more comfortable for the patient than will double-contrast barium enema, because only a small amount of additional air insufflation is needed.

A final benefit of CT colonography is that the right colon is usually the segment optimally distended during this examination. Because the right colon is the segment most often not visualized during colonoscopy, CT colonography is

well suited to complete the examination of patients with incomplete colonoscopy.

Our study has several limitations. First, our patient population was not randomized into arms comparing double-contrast barium enema and CT colonography. We omitted this randomization because double-contrast barium enema is considered the gold standard for colonic evaluation after incomplete colonoscopy. Our initial study suggests that in the setting of incomplete colonoscopy, CT colonography is comparable with double-contrast barium enema. Second, although the radiologists did not receive the colonoscopy results, the barium enema and CT colonography were often (70% of the time) performed by the same radiologist. This fact could introduce some bias in the results. However, this study was not an attempt to formally compare double-contrast barium enema and CT colonography. We do believe, however, that these reported results support the need for a large-scale randomized trial that not only includes an estimate of sensitivity, specificity, and accuracy but also formally assesses patient preference.

In conclusion, CT colonography is technically effective in evaluating segments of the colon not visualized during colonoscopy. The preliminary data suggest that CT colonography has an adjunctive role in patients with incomplete colonoscopy.

References

1. Parker SH, Torry T, Bolden S, Windigo PA. Cancer statistics 1996. *CA Cancer J Clin* **1996**;65:5–27
2. Mandel JS, Bond JH, Church TR, et al. Reducing the mortality from colorectal cancer by screening for fecal occult blood. *N Engl J Med* **1993**;328:1365–1371
3. Winawer SJ, Zauber AG, Ho MN, et al. Prevention of colorectal cancer by colonoscopic polypectomy. *N Engl J Med* **1993**;329:1977–1981
4. Muller AD, Sonnenberg A. Protection by endoscopy against death from colorectal cancer: a case control study among veterans. *Arch Intern Med* **1995**;155:1741–1748
5. Eddy DM. Screening for colorectal cancer. *Ann Intern Med* **1990**;113:373–384
6. Anderson ML, Heigh RI, McCoy GA, et al. Accuracy of assessment of the extent of examination by experienced colonoscopists. *Gastrointest Endosc* **1992**;38:560–563
7. Fenlon HM, McAneny DB, Nunes DP, Clarke PD, Ferrucci JT. Occlusive colon carcinoma: virtual colonoscopy in the preoperative evaluation of the proximal colon. *Radiology* **1999**;210:423–428
8. Hara AK, Johnson CD, Reed JE, et al. Detection of colorectal polyps with CT colography: initial assessment of sensitivity and specificity. *Radiology* **1997**;205:59–65
9. Fenlon HM, Ferrucci JT. Virtual colonoscopy: what will the issues be? *AJR* **1997**;169:453–458
10. Rex DK, Lehman GA, Ulbright TM, et al. Colonic neoplasia in asymptomatic persons with negative fecal occult blood tests: influence of age, gender, and family history. *Am J Gastroenterol* **1993**;88:825–831
11. Winawer SJ, Fletcher RH, Miller L, et al. Colorectal cancer screening: clinical guidelines and rationale. *Gastroenterology* **1997**;112:594–642
12. Laufer I. Barium studies: principles of double contrast diagnosis. In: Gore RM, Levine MS, Laufer I, eds. *Textbook of gastrointestinal radiology*. Philadelphia: Saunders, **1994**:38–49