

Location of Adenomas Missed by Optical Colonoscopy

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Background: Previous estimates of the adenoma miss rate with optical colonoscopy (OC) are hindered by the use of OC as its own reference standard.

Objective: To evaluate the frequency and characteristics of colorectal neoplasms that are missed prospectively on OC by using virtual colonoscopy (VC) as a separate reference standard.

Design: Prospective, multicenter screening trial.

Setting: 3 medical centers.

Participants: 1233 asymptomatic adults who underwent same-day VC and OC.

Measurements: Colorectal neoplasms (adenomatous polyps) missed at OC before VC results were unblinded.

Results: Fourteen (93.3%) of 15 nonrectal neoplasms were located on a fold; 10 (71.4%) of these were located on the backside

of a fold. Five (83.3%) of 6 rectal lesions were located within 10 cm of the anal verge.

Limitations: Estimation of the OC miss rate depended on polyp detection on both VC and second-look OC and therefore underestimates the true OC miss rate, particularly for smaller polyps.

Conclusions: Most clinically significant adenomas missed prospectively on OC are located behind a fold or near the anal verge. The 12% OC miss rate for large adenomas (≥ 10 mm) when state-of-the-art 3-dimensional VC is used as a separate reference standard is increased from the previous 0% to 6% estimates derived by using OC as its own reference standard.

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Optical colonoscopy (OC) is widely accepted as the gold standard for detecting colorectal neoplasia (1, 2). However, even in the most experienced hands, this skilled examination is understandably not infallible. Retrospective analysis has suggested that the OC miss rate for adenomas 10 mm or greater is approximately 10% (3). More recently, prospective back-to-back or "tandem" colonoscopy studies have reported miss rates for 10-mm adenomas ranging from 0% to 6% (4, 5). However, in addition to evaluating relatively small populations of patients with a high prevalence of polyps, a notable weakness common to these studies was that they used OC as its own reference standard.

In a large, prospective, multicenter trial that was primarily intended to evaluate the performance of virtual colonoscopy (VC) in asymptomatic adults (6), we also had a unique opportunity to evaluate the adenoma miss rate on OC by "segmentally unblinding" the results from same-day VC. By using a reference standard other than OC itself for comparison, we could uncover lesions that may be systematically missed on repeated colonoscopies. These data not only provide novel insight into OC miss rates but also indicate the relative "blind spots" where more attention could be focused.

METHODS

Study Design

The institutional review boards at all 3 participating medical centers approved the study protocol for same-day VC and OC, and all patients provided written informed consent. We recruited asymptomatic adults who were referred for colorectal cancer screening. Exclusion criteria were a positive stool guaiac test result or iron deficiency anemia within the past 6 months; rectal bleeding, hema-

tochezia, or unintentional weight loss of more than 10 pounds within the past 12 months; OC within the past 10 years or barium enema within the past 5 years; personal history of adenomatous polyps, colorectal cancer, or inflammatory bowel disease; and family history of familial adenomatous polyposis or nonpolyposis cancer syndromes.

Between May 2002 and June 2003, 1253 asymptomatic adults enrolled in the study. Eight patients were excluded because of failure to reach the cecum at OC, 6 patients were excluded because of inadequate colonic preparation, and another 6 patients were excluded because of computed tomography (CT) system failure. The final study group comprised 1233 asymptomatic adults (728 men and 505 women; mean age, 57.8 years) who successfully completed same-day VC and OC.

Study participants underwent colonic preparation with oral intake of 90 mL of phospho-soda and 10 mg of bisacodyl. To opacify residual colonic fluid and stool for VC examination, patients also consumed dilute oral contrast as previously described (7). Our CT protocol and VC technique have also been detailed previously (6). To briefly summarize, we obtained supine and prone CT acquisitions on multidetector scanners after patient-controlled rectal insufflation of room air. One of 6 trained radiologists interpreted VC studies by using a commercially available CT colonography system (Viatronix V3D-Colon, version 1.2, Viatronix, Inc., Stony Brook, New York). We used the 3-dimensional endoluminal fly-through view primarily for detecting polyps and 2-dimensional images for confirmation and problem solving. We measured polyps on the 3-dimensional view and recorded them by segment (cecum, ascending colon, hepatic flexure, transverse colon, splenic flexure, descending colon, sigmoid colon, or rectum). We defined the proximal colon as including the ce-

cum to the splenic flexure. We prospectively rated diagnostic confidence for each detected lesion on a 3-point scale (most certain, intermediate, and least certain).

One of 17 experienced colonoscopists performed OC immediately after VC interpretation by using standard commercial video colonoscopes (Olympus, Inc., Melville, New York). The colonoscope was advanced to the cecum and then sequentially withdrawn into more distal segments for polyp detection. The colonoscopist measured polyps by using a calibrated linear probe, which is more accurate than either visual or biopsy forceps estimation (8). Our polyp-matching algorithm requires VC and OC agreement according to size (within a 50% margin of error) and location (within the same or adjacent segment). After the colonoscopist evaluated a given segment, a study nurse unblinded the VC results for the previous segment. For any suspected polyp seen on VC that measured 5 mm or greater but was not seen on the initial blinded OC, the colonoscopist closely reexamined that segment and could review the VC images for guidance. We sent all retrieved polyps for histologic examination.

For all cases in which a colorectal neoplasm measuring 6 mm or greater was found on second-look OC, we retrospectively reviewed both the VC and OC images. We recorded polyp characteristics, such as size, morphologic characteristic (sessile, pedunculated, or flat), and location on VC. If the polyp was situated on a colonic fold on VC, we further subcategorized it as being located on the back (proximal) side, front (distal) side, or edge of the fold. We analyzed both supine and prone VC sets for all cases. The primary reason that diminutive polyps measuring 5 mm at VC were included for potential unblinding at OC was that, given the relative error in polyp measurement, such polyps found on second-look OC might, in fact, measure 6 mm or greater. This allows for more accurate assessment of the OC miss rate at the 6-mm threshold. We did not include unblinded polyps that measured 5 mm or less on both VC and OC examinations in the final analysis.

All study participants completed a detailed questionnaire on their personal and family medical history. For the purposes of this study, particular attention was given to the question about previous abdominal or pelvic surgery, since adhesions could conceivably result in a more difficult colonoscopic examination.

Statistical Analysis

Prospective OC performance was compared against the enhanced reference standard of second-look OC after segmental unblinding of VC results. We estimated exact binomial 95% CIs for OC miss rates. We used the chi-square test to compare the frequency of previous abdominal surgery among patients with and without polyps missed at OC and also to compare the OC miss rates among the 3 medical centers. We calculated the 95% CIs by using Stata software, version 7.0 for Windows (Stata Corp., College Station, Texas), and performed the chi-

Context

How often does colonoscopy miss adenomas?

Contribution

During a multicenter screening trial, experienced colonoscopists performed same-day optical (OC) and virtual colonoscopy (VC) on 1233 asymptomatic adults. Optical colonoscopy performed without knowledge of the VC findings missed 55 of 511 polyps; 21 of these polyps were adenomas measuring 6 mm or greater. Adenomas missed by OC were usually on the proximal side of a fold or near the anal verge. Virtual colonoscopy missed 14% of the adenomas that measured 6 mm or greater that were detected by OC.

Implications

Neither OC nor VC is a perfect test: Each misses 10% to 14% of adenomas that measure 6 mm or greater.

—The Editors

square tests by using SAS software, version 8.0 for Windows (SAS Institute, Inc., Cary, North Carolina).

Role of the Funding Source

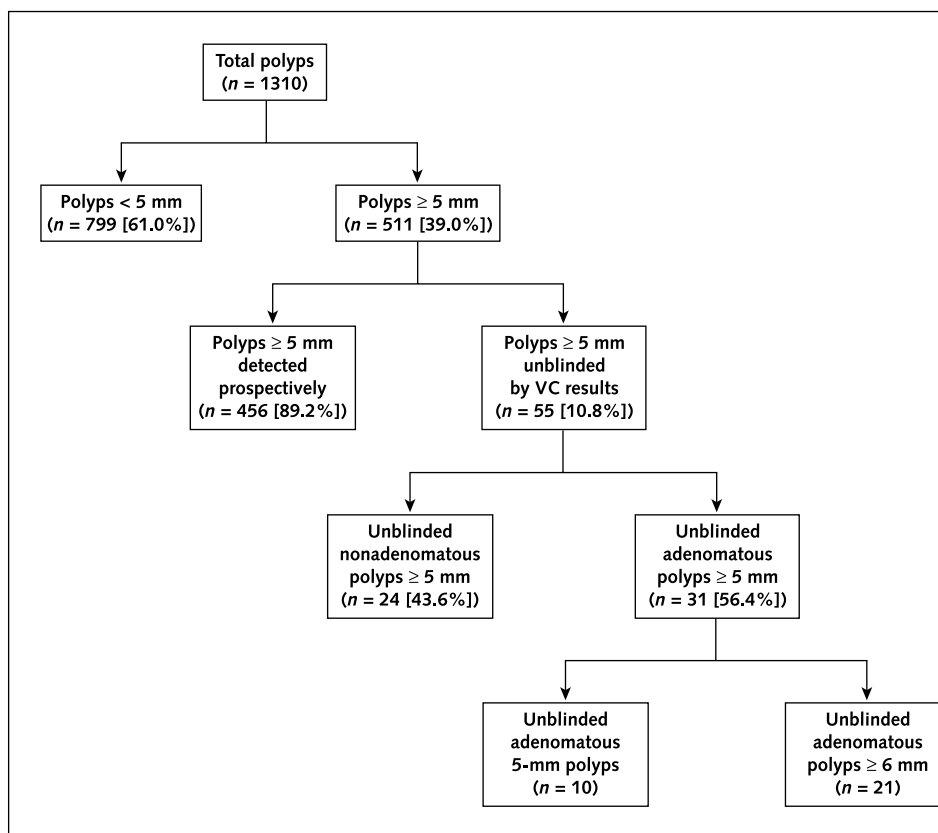
The funding source had no role in the collection, analysis, or interpretation of the data or in the decision to submit the manuscript for publication.

RESULTS

The performance characteristics of VC from this prospective, multicenter screening trial, using OC as the reference standard, have been previously reported (6). Our technique of segmental unblinding also allows for a separate assessment of OC by using the blinded VC results for comparison, which is the focus of this study. We identified 1310 polyps at OC in the 1233 asymptomatic adults; 511 (39.0%) of these polyps measured 5 mm or greater (Figure 1). Of these 511 polyps, 55 (10.8%) were found only on second-look OC after segmental unblinding of VC results. Twenty-four (43.6%) of the 55 unblinded lesions were nonadenomatous, including 16 hyperplastic polyps. Of the 31 missed neoplasms, 10 adenomas that measured only 5 mm were excluded from further analysis because of their diminutive size (9). Including unblinded lesions, 554 adenomas were detected on OC in this screening sample; 210 of these measured 6 mm or greater and 51 measured 10 mm or greater.

In 20 patients (17 men and 3 women; mean age, 58.2 years), 21 adenomas measuring 6 mm or greater (range, 6 mm to 17 mm; mean, 8.1 mm) were found on OC only after the VC results were unblinded, which represent the lesions of primary interest for this study (Table). The corresponding adenoma miss rate on prospective OC examination was 10.0% (95% CI, 6.3% to 14.9%) (21 of 210

Figure 1. Polyp flowchart.



Flowchart shows the total number of polyps detected; the number of polyps eligible for unblinding (size ≥ 5 mm); and the number of unblinded adenomas that measured 6 mm or larger, which represent the primary study group. The 10 unblinded adenomas that measured 5 mm were excluded because of their diminutive size. VC = virtual colonoscopy.

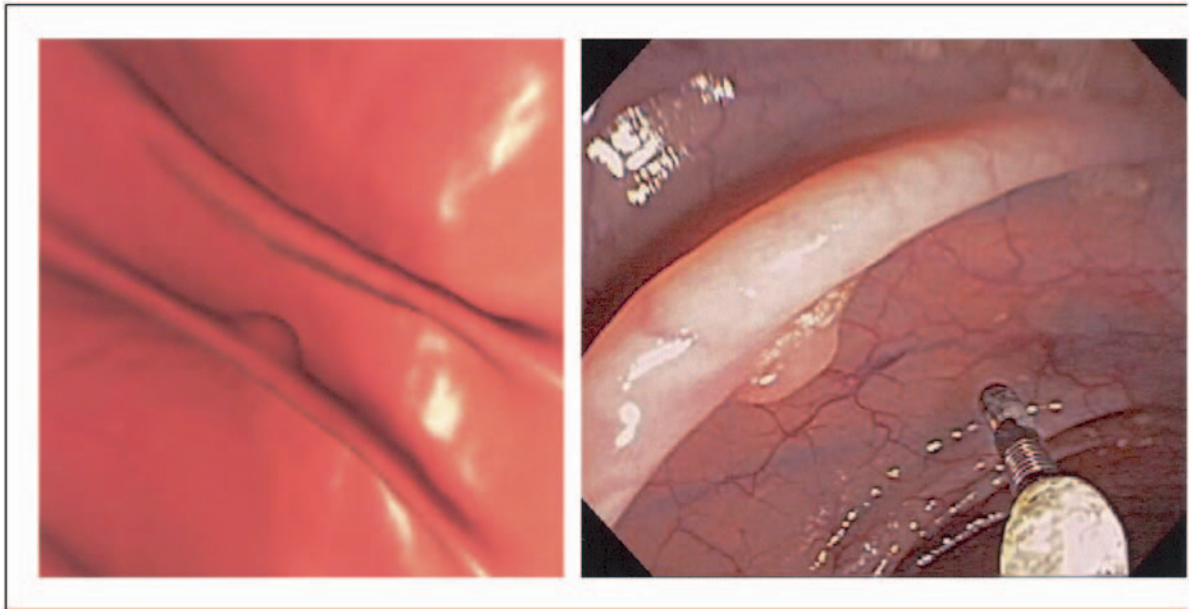
adenomas) at a 6-mm cutoff. The 20 patients with missed adenomas that measured 6 mm or greater represented only 1.6% of the study sample (20 of 1233 patients) but 11.9% of patients with adenomas 6 mm or greater (20 of 168

patients). At 8-mm and 10-mm thresholds, the OC adenoma miss rates by polyp were 10.5% (CI, 5.2% to 18.5%) (10 of 95 adenomas) and 11.8% (CI, 4.4% to 23.9%) (6 of 51 adenomas), respectively. The 10 patients

Table. Characteristics of Neoplasms Missed at Prospective Colonoscopic Evaluation

Neoplasm	Size, mm	Segment	Morphologic Characteristic	On a Fold?	Histologic Characteristic
1	17	Descending colon	Pedunculated	Yes (back)	Tubulovillous adenoma
2	11	Rectum	Sessile	Yes (front)	Tubular adenoma
3	11	Hepatic flexure	Pedunculated	Yes (edge)	Adenocarcinoma
4	10	Ascending colon	Sessile	Yes (back)	Tubular adenoma
5	10	Ascending colon	Pedunculated	Yes (back)	Tubular adenoma
6	10	Rectum	Sessile	No	Tubulovillous adenoma
7	8	Ascending colon	Sessile	Yes (back)	Tubular adenoma
8	8	Rectum	Sessile	Yes (front)	Tubular adenoma
9	8	Ascending colon	Sessile	Yes (front)	Tubular adenoma
10	8	Rectum	Sessile	No	Tubulovillous adenoma
11	7	Rectum	Flat	No	Tubular adenoma
12	7	Ascending colon	Sessile	Yes (back)	Tubular adenoma
13	7	Transverse colon	Sessile	Yes (back)	Tubular adenoma
14	6	Transverse colon	Sessile	Yes (edge)	Tubular adenoma
15	6	Ascending colon	Sessile	Yes (front)	Tubular adenoma
16	6	Rectum	Flat	No	Tubular adenoma
17	6	Descending colon	Sessile	Yes (back)	Tubular adenoma
18	6	Sigmoid colon	Sessile	Yes (back)	Tubular adenoma
19	6	Hepatic flexure	Sessile	Yes (back)	Tubular adenoma
20	6	Sigmoid colon	Pedunculated	Yes (back)	Tubular adenoma
21	6	Sigmoid colon	Sessile	No (flexure)	Tubular adenoma

Figure 2. Unblinded 6-mm tubular adenoma located on the proximal aspect of a fold at the hepatic flexure.



Left. Three-dimensional endoluminal view from virtual colonoscopy shows a sessile polyp situated on the backside of a colonic fold. **Right.** Digital photograph from optical colonoscopy shows the same polyp, which was found after segmental unblinding of the virtual colonoscopy results. Note the adjacent calibrated guidewire used for polyp measurement in the study.

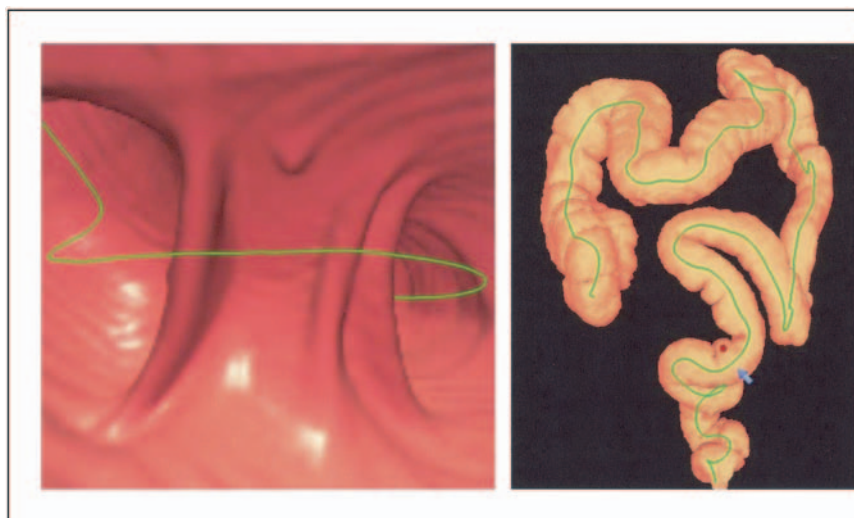
with missed adenomas 8 mm or greater represented 12.2% (10 of 82 patients) of all patients with neoplasms of this size or greater; the 6 patients with missed adenomas 8 mm or greater represented 12.5% of all patients with neoplasms 10 mm or greater.

Seventeen (81.0%) of the 21 unblinded neoplasms 6 mm or greater were tubular adenomas, 3 (14.3%) were tubulovillous adenomas, and 1 (4.8%) was an adenocarcinoma. Seven (33.3%) of the 21 unblinded polyps

were classified as advanced lesions (that is, size ≥ 10 mm or high-grade dysplasia, prominent villous component, or focus of malignancy). There were 15 sessile lesions, 4 pedunculated lesions, and 2 flat lesions. Eight (40%) of the 20 patients had an additional adenoma that measured 6 mm or greater; OC prospectively detected the additional adenoma in 7 (87.5%) of these patients.

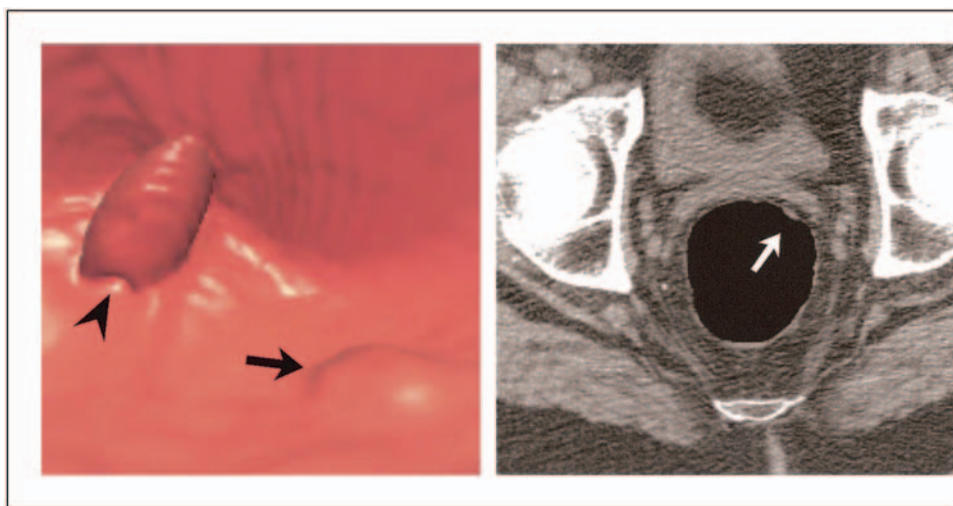
Ten (47.6%) of the 21 missed neoplasms were located in the proximal colon, and 6 (54.5%) of the 11 distal

Figure 3. Unblinded 6-mm tubular adenoma located at the inner aspect of a sigmoid flexure.



Left. Three-dimensional endoluminal view from virtual colonoscopy shows a sessile polyp situated between folds. The centerline path for automated navigation is shown (*line*). **Right.** Colon map generated from the supine computed tomography data set that shows the vantage point (*arrow*) for the image on the right. The polyp location (*circle*) is situated at the inner turn of the flexure.

Figure 4. Unblinded 7-mm tubular adenoma located in the distal rectum.



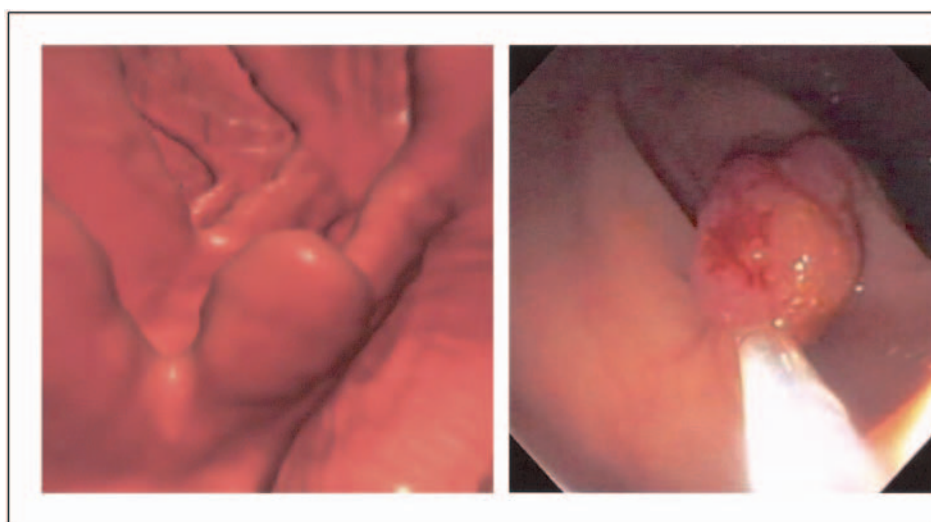
Left. Three-dimensional endoluminal view from virtual colonoscopy that simulates retroflexed view of rectal ampulla shows a subtle flat lesion (*arrow*) that measured 7 cm from the anal verge. Note the tip of small rectal catheter (*arrowhead*) that was used for air insufflation. Right. Two-dimensional axial computed tomography image with soft tissue windowing confirms the presence of a flat rectal lesion (*arrow*).

lesions were located in the rectum (Table). Of the 15 missed nonrectal neoplasms, 14 (93.3%) were located on a fold at VC examination (Figure 2). Of these, 10 (71.4%) were situated on the proximal aspect (Figure 2) and the remaining 4 polyps were located on the distal aspect (2 polyps) and edge of the fold (2 polyps). The adenoma proximal to the rectum that was not associated with a fold was located at the inner aspect of a flexure (Figure 3). Of the 6 missed adenomas in the rectum, 5 (83.3%) measured within 10 cm of the anal verge on VC (Figure 4). The missed adenocarcinoma was located at or near the hepatic flexure (Figure 5). We believe that this malignant polyp

was initially missed at OC because of repeated slippage of the instrument at the hepatic flexure, resulting in incomplete initial evaluation of that region.

On retrospective VC review of the 21 neoplasms missed prospectively at OC, 19 (90.5%) neoplasms could be identified on both the supine and prone VC data sets. Two polyps were clearly identified on only 1 position each (supine and prone, respectively). We reviewed the diagnostic confidence level from the initial prospective VC interpretation for these unblinded adenomas. The interpreting radiologist recorded the confidence level as “most certain” (level 3) in 16 cases (76.2%), “least certain” (level 1) in 3

Figure 5. Unblinded 11-mm malignant polyp located near the hepatic flexure.



Left. Three-dimensional endoluminal view from virtual colonoscopy shows a large polypoid lesion on the edge of a fold. Right. Digital photograph from optical colonoscopy shows the same polyp, which was found only after several attempts to reposition the instrument because of repeated slippage in this region. Invasive adenocarcinoma was confirmed at surgery.

cases (14.3%), and “intermediate” (level 2) in 2 cases (9.5%). To clarify, a diagnostic confidence level of 1 indicates that the VC reader called a polyp in that location but was least certain that the finding would correspond to a true lesion on OC.

Nine (45%) of the 20 patients with an unblinded neoplasm 6 mm or greater reported a history of abdominal or pelvic surgery: 3 hysterectomies, 3 herniorrhaphies, 2 appendectomies, and 1 splenectomy. The frequency of previous surgery did not significantly differ from that in the remainder of the study sample, in which 490 (40.4%) of 1213 patients reported a surgical history ($P > 0.2$).

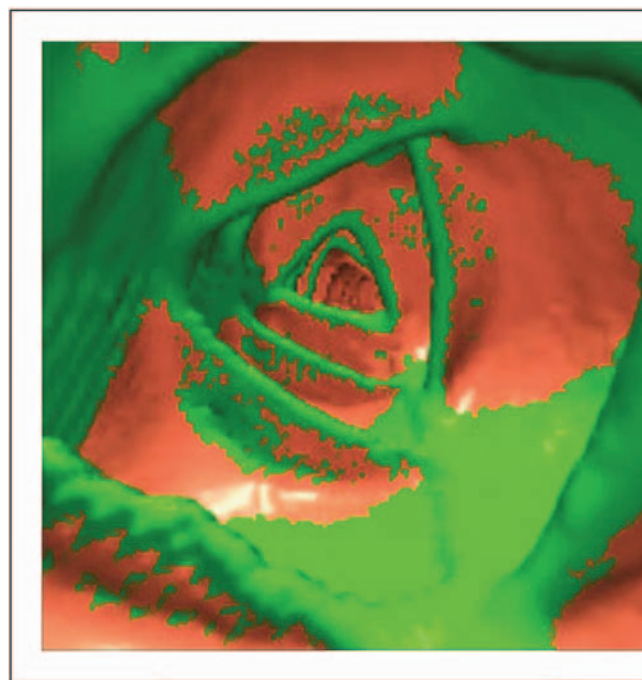
A group of 17 experienced staff physicians (14 gastroenterologists and 3 colorectal surgeons) performed all colonoscopies. Examination was incomplete because of failure to reach the cecum in 8 patients, yielding a 99.4% completion rate (1233 of 1241 patients). The OC miss rates for adenomas that measured 6 mm or greater for the 3 participating medical centers were 12.0% (6 of 50 adenomas), 12.0% (10 of 83 adenomas), and 6.5% (5 of 77 adenomas), respectively. The differences were not statistically significant ($P > 0.2$). The OC miss rates by the 3 medical centers for adenomas 10 mm or greater was 11.1% (1 of 9 adenomas), 12.5% (3 of 24 adenomas), and 11.1% (2 of 18 adenomas), respectively. Colorectal surgeons performed the screening examinations for 3 of the 21 (14.3%) unblinded adenomas 6 mm or greater, and the remaining cases were performed by gastroenterologists. This surgeon-to-gastroenterologist ratio was similar to the ratio for the entire trial. No colonoscopist missed more than 1 adenoma that measured 10 mm or greater, and only 2 colonoscopists missed more than 1 adenoma that measured 6 mm or greater.

The adenoma miss rates for VC in our trial were 14.3% (30 of 210 adenomas), 7.4% (7 of 95 adenomas), and 7.8% (4 of 51 adenomas) at 6-mm, 8-mm, and 10-mm thresholds, respectively. The miss rates were higher for OC compared with VC for adenomas measuring 8 mm and larger. All known lesions missed by one method were necessarily detected on prospective evaluation by the other method, which underscores the complementary nature of VC and OC. The mean size of the 30 nondiminutive adenomas missed at VC was 7.3 mm, and the segmental locations were rectum ($n = 0$), sigmoid colon ($n = 4$), descending colon ($n = 2$), splenic flexure ($n = 2$), transverse colon ($n = 5$), hepatic flexure ($n = 3$), ascending colon ($n = 4$), and cecum ($n = 10$).

DISCUSSION

The previously reported estimates of adenoma miss rates at OC have all relied on subsequent polyp detection by OC itself, whether by prospective “tandem” colonoscopy studies (4, 5) or inferred from data on “recurrent” adenomas found after previous clearing colonoscopy (3, 10, 11). With regard to the latter, most adenomas detected at short-term postpolypectomy surveillance are believed to

Figure 6. Potential colonoscopic “blind spots.”



Antegrade endoluminal view (that is, looking distally toward rectum) from virtual colonoscopy indicates the portions of colonic mucosa that were visualized during retrograde flight toward the cecum by “painting” the surface green. The unpainted regions involving the proximal aspects of colonic folds are readily evaluated during antegrade flight on virtual colonoscopy. These regions, however, are the most common sites for missed adenomas at optical colonoscopy because of its unidirectional nature.

actually represent lesions missed during the index OC (12). The fact that OC has been the reference standard to determine its own miss rates is a major drawback, largely because systematic errors from certain “blind spots” can go undetected on repeated examination. For example, if a polyp is initially missed at OC primarily because of its location (such as behind a fold) and not because of perceptual error, it is more likely to be missed at subsequent OC evaluation unless the colonoscopist is specifically directed to that location. We believe that this study is the first to directly investigate the adenoma miss rate at OC by using a separate standard for comparison.

Segmental unblinding is useful for evaluating VC performance in prospective clinical trials, since matched polyps that have been unblinded are not incorrectly labeled as false-positive VC results (6). An additional benefit of segmental unblinding in this setting is that it can also assess OC performance, which allows for simultaneous evaluation of both VC and OC. Pineau and colleagues (13) used segmental unblinding in a recent VC study that evaluated 205 patients and uncovered 2 adenomas that measured 6 mm or greater. Virtual colonoscopy, of course, also misses adenomas, and in our experience, the VC miss rate for nondiminutive lesions is similar to that seen with OC (6). An in-depth analysis of the VC miss rate, however, is beyond

the scope of this paper. Nonetheless, VC and OC represent complementary techniques for polyp detection since all known polyps missed by 1 study are necessarily detected by the other. Our findings underscore the enormous potential benefit of adding VC to the front-line screening armamentarium. In actual clinical practice, the positive results on a screening VC examination would, of course, not be blinded at subsequent therapeutic OC. Therefore, the colonoscopist would have a priori knowledge of polyp size, morphologic characteristics, and specific location at VC. In this setting, the overall sensitivity for detecting adenomas would be expected to increase over OC alone.

The location characteristics of adenomas missed prospectively at OC in our study recapitulate the various suspected pitfalls that have been previously described (14). These areas include the proximal side of folds, the inner aspect of flexures, and the distal rectum (Figures 2 to 4). An additional pitfall occurs at the hepatic flexure, where the instrument can slip during withdrawal (Figure 5). These relative weaknesses primarily relate to the unidirectional nature and other tactical challenges of physical endoscopy. In our series, polyp localization on the proximal side of a colonic fold accounted for two thirds of missed adenomas beyond the rectum (Figure 6). Meticulous maneuvers and technical advances (15, 16) to physically flatten folds or otherwise improve visualization behind folds must be balanced with the need for efficient examination. Despite the performance of retroflexion in the rectal ampulla (17), missed adenomas near the anal verge were also relatively common in our series. None of these pitfalls were insurmountable since all adenomas reported herein were detected at directed second-look OC, but they do demonstrate the added value of the VC results. Because VC is not constrained by direction, many of these adenomas were readily detectable during antegrade endoluminal navigation (from cecum to rectum).

The OC miss rate for large adenomas (≥ 10 mm) in our study is notably higher than that reported in the smaller tandem or back-to-back OC studies (4, 5). The primary reason for this difference, as previously noted, is probably related to using VC as a distinct reference standard. Prevalence of disease is another important factor that must be considered because of its effect on an examiner's index of suspicion. In the tandem OC study by Hixson and colleagues (4), the prevalence of adenomas that measured 10 mm or greater was 34% (31 of 90 patients), compared with 4% (48 of 1233 patients) in our series. Likewise, in the tandem study by Rex and colleagues (5), the prevalence of adenomas 6 mm or greater was 30% (54 of 183 patients), compared with 14% (168 of 1233 patients) in our study. Regardless of reference standard, the OC miss rate would probably increase as disease prevalence decreases.

Similar to previous studies (5), the chance of having a missed adenoma at initial OC before unblinding in our study was greater for patients in which an additional adenoma that measured 6 mm or greater was already found.

Of interest, the 10.0% OC miss rate for adenomas that measured 6 mm or greater in our study was identical to that reported by Rex and colleagues (8 of 80 adenomas) (5). The lower OC miss rate for smaller lesions (that is, 6-mm vs. 10-mm thresholds) in our study may seem paradoxical at first glance. This apparent increase in OC sensitivity for smaller adenomas measuring 6 mm to 9 mm is probably related to both a true decrease in VC sensitivity (resulting in relatively fewer opportunities for unblinding at OC) and a true decrease in OC sensitivity (resulting in fewer detections on second-look OC). Additional factors may include the increased difficulty in VC–OC polyp matching with smaller lesions and the increased prevalence of these lesions overall.

The reported miss rates for OC (as well as for VC) will always be somewhat underestimated simply because some lesions will probably escape detection by all available diagnostic means, given that no infallible standard exists. For a polyp to be “unblinded” and counted as a miss on OC (false-negative), 2 things are required: 1) VC must first detect the polyp that is subsequently missed at prospective OC and 2) second-look OC must find the polyp that the prospective OC initially missed. At least some of the remaining false-positive results on VC in our study may actually be true lesions that were not detected at OC despite a second look.

Although subpar colonoscopic performance could have conceivably resulted in some of the missed adenomas in our study, certain factors make this less likely. First, our OC completion rate of 99.4% is among the highest rates reported; this generally indicates the high skill level of the colonoscopists involved in this study. Second, as with the tandem OC studies, all colonoscopists knew that their misses were being recorded. This knowledge no doubt resulted in some surveillance bias with very meticulous examination. Therefore, we believe that the lesions missed at OC before the VC results were unblinded truly reflect areas of relative weakness, especially since nearly all missed lesions could be categorized according to recognized or suspected OC pitfalls.

We should also note that the addition of oral contrast to the colonic preparation did not negatively affect OC performance (18). Rather, the fidelity of preparation was generally considered to be superior to that of more standard OC preparation, possibly because of the effect of the water-soluble contrast on bowel motility. The orally administered barium for solid-stool tagging is a 2% suspension, as compared with the 58% concentration typically used for air-contrast enemas, and did not affect mucosal visualization at OC.

The results and conclusions from this study rely heavily on the use of state-of-the-art VC technique to reliably detect polyps missed at OC. Specific advances include using the 3-dimensional fly-through for primary polyp detection, oral contrast for tagging residual fluid and stool, and CT-slice collimation not in excess of 2.5 mm. Proper

training of experienced radiologists is also critical. Using obsolete VC techniques, inexperienced readers, or both will predictably lead to an overestimation of OC performance, since VC detection is a necessary step in the segmental unblinding process. An older but recently published VC trial illustrated this overestimation by using outdated methods (19). This study, which the lay press unfortunately reported as “new,” reported VC and OC sensitivities in the ranges of 39% to 55% and 99% to 100%, respectively. Shortcomings in the VC method for this gastroenterologist-led study included the use of 2-dimensional CT images for polyp detection, lack of oral contrast tagging, CT-slice collimation up to 5 mm, and suboptimal radiologist training. The OC sensitivities are clearly overestimated in this study because, for missed lesions to be uncovered, VC must first detect these lesions.

In conclusion, OC is a sensitive diagnostic tool for detecting colorectal neoplasia. However, despite the utmost attention to technique, even experienced colonoscopists will occasionally miss significant lesions. By using VC as a separate standard of reference, our study confirms that distinct locations on OC examination represent relative blind spots where clinically significant polyps can sometimes be missed. These findings are an important reminder for colonoscopists and indicate the need for continued improvements in colonoscopic technology.

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