Latest Generation, Wide-Angle, High-Definition Colonoscopes Increase Adenoma Detection Rate

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BACKGROUND & AIMS: Improvements to endoscopy imaging technologies might improve detection rates of colorectal cancer and patient outcomes. We compared the accuracy of the latest generation of endoscopes with older generation models in detection of colorectal adenomas. **METHODS:** We compared data from 2 prospective screening colonoscopy studies (the Berlin Colonoscopy Project 6); each study lasted approximately 6 months and included the same 6 colonoscopists, who worked in private practice. Participants in group 1 (n = 1256) were all examined by using the latest generation of wide-angle, high-definition colonoscopes that were manufactured by the same company. Individuals in group 2 (n = 1400) were examined by endoscopists who used routine equipment (a mixture of endoscopes from different companies; none of those used to examine group 1). The adenoma detection rate was calculated on the basis of the number of all adenomas/number of all patients. **RESULTS:** There were no differences in patient parameters or withdrawal time between groups (8.0 vs 8.2 minutes). The adenoma detection rate was significantly higher in group 1 (0.33) than in group 2 (0.27; $P = .01$); a greater number of patients with least 1 adenoma were identified in group 1 (22.1%) than in group 2 (18.2%; $P = .01$). A higher percentage of high-grade dysplastic adenomas were detected in group 1 (1.19%) than in group 2 (0.57%), but this difference was not statistically significant ($P = .06$). **CONCLUSIONS: The latest generation of wide-angle, high-definition colonoscopes improves rates of adenoma detection by 22%, compared with mixed, older technology endoscopes used in routine private practice. These findings might affect definitions of quality control parameters for colonoscopy screening for colorectal cancer.**

Keywords: Adenoma Detection Rate (ADR); Early Detection; Colon Cancer; CRC; Screening Trial; BECOP-6.

Screening colonoscopy has been shown to decrease colorectal cancer (CRC) incidence as well as mortality,[1] not only by finding cancers at an earlier stage but even more because of the detection and removal of adenomas as precursor lesions. Thus, the adenoma detection rate (ADR) has been considered to be one of the main quality outcome parameters of screening colonoscopy.[2] ADR has recently been shown to correlate with colonoscopy withdrawal times.[3] Adenoma rates reported from various countries have ranged from 8%–35%,[4–10] and it is not known whether these differences reflect differences in disease prevalence or perhaps also in colonoscopy quality.

Among the potential factors for improving the quality of colonoscopy and increasing the ADR, the use of new technology has often been advocated, but only a few studies have focused on this issue. Such studies, moreover, have dealt with specific refinements within one endoscope generation such as wide-angle imaging,[11] use of image processing such as narrow band imaging (NBI),[12–15] or Fuji Intelligent Color Enhancement.[16,17] Although these studies could not consistently show differences in outcome, instrument quality in the control groups always represented the most up-to-date standard endoscopes.

Larger randomized comparisons of different generations of instruments, which arrive with a variety of improvements in imaging, image resolution, and image processing, have not been performed yet. In daily routine and especially in private practice, colonoscopy is performed with various generations of instruments, mostly not of the latest generation. However, there are no published data on the question of whether and to what extent introduction of new technology might improve outcome as compared with daily routine. A small recent randomized study found a 3-fold increase in ADR when using the latest generation instrument as compared with the previous endoscope generation.[18]

We therefore compared the performance of the same 6 Berlin colonoscopists who participated in 2 prospective studies. Data from these 6 endoscopists were taken from the large prospective quality assurance study performed by a total of 21 colonoscopists that was examining the influence of case volume on adenoma detection[19] as well as documentation quality of main screening colonoscopy outcome parameters.[20] The other study was a prospective randomized comparison of high-definition television (HDTV) colonoscopies with and without NBI, which were performed by this group of 6 colonoscopists and which did not show any difference in adenoma detection.[15]

Methods

Two groups of screening colonoscopy patients from 2 successive prospective study periods were analyzed with respect to ADR (all adenomas/all patients). All colonoscopies were performed during the 2 study periods in 5 private gastroenter-

Abbreviations used in this paper: ADR, adenoma detection rate; CRC, colorectal cancer; HDTV, high-definition television; HGIN, high-grade intraepithelial neoplasia; NBI, narrow band imaging.

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ology practices in Berlin by the same 6 colonoscopists, each with outpatient screening colonoscopy volumes of >500 per year; the lifetime experience of the participating examiners was >10,000 colonoscopies each. Both study periods spanned 6–7 months.

Study Group I: Latest and Uniform Technology

Data for this group was recruited from a prospective randomized study by using exclusively the latest generation Olympus (Tokyo, Japan) colonoscopes to compare conventional wide-angle HDTV colonoscopy with and without NBI, with ADR as the main outcome parameter; instrument, processor, as well as screen were of the same HDTV generation. The comparative results of this study, which did not show any differences in ADR between the 2 groups in any of the parameters analyzed, were reported elsewhere.[15] Because no differences were found in this comparative study between the group in which NBI was used and the group in which HDTV imaging alone was used, data of both the NBI and non-NBI groups are combined for the present comparative analysis. We consider this group to be the one in which the most modern technology, namely high-resolution HDTV imaging, was used.

Study Group II: Older Generation Endoscopes

Of 18 private practices with 21 physicians in Berlin who performed a quality assessment study of screening colonoscopy and included 12,134 cases during a total of 18 months,[19] colonoscopy data (n = 1400) from 6 of 18 colleagues were extracted during the first 6 months of their study participation to arrive at an equal time period compared with the retrospective analysis. In the abovementioned study, various performance parameters, findings, and complications were assessed in this study as well as patient acceptance (evaluated by questionnaire) until study termination. ADR was one of the main quality outcome parameters of this trial. A study audit was performed for all participating centers to achieve high data completeness except for nonconsenting patients. The instruments routinely used in these 5 practices came from different companies but did not represent the latest generation instruments of the respective companies. They were from Pentax (EC-3870, EC-3940; Pentax Europe Co, Hamburg, Germany) in 3 practices and from Fujinon (EC 201 WI, EC 200 MR, EC 250 WI5; Fujinon Europe Co, Willich, Germany) and Olympus (PCF-100 and CF-145; Olympus Europe Co, Hamburg, Germany) in 1 practice each. Respective processors of the same generation were used; screens were not of HD quality.

Data Acquisition and Recorded Parameters

Ethical approval from the Charité Ethical Committee was obtained for the 2 prospective studies (EA 02/019/07 and EA 02/018/07) that involved either data acquisition/follow-up and/or use of a new scope imaging technology (HDTV/NBI).

The following parameters were recorded: (1) cecal intubation rate; (2) number of adenomas, with location, size, and histology; because of the unclear definition of flat adenomas in the retrospective analysis, this parameter was not included in our 3-group comparison; (3) number of hyperplastic polyps, with location and size; and (4) examination times (introduction and withdrawal).

Outcome Parameters

The main outcome parameter was the ADR, calculated as number of all adenomas/number of all patients. Secondary outcome parameters were the percentage of patients with at least 1 adenoma, the rate of high-grade dysplastic adenomas as special risk lesions, and the overall number of hyperplastic polyps.

Data Completeness

In the modern technology study (group I), only 2 instruments were available in the participating offices, leading to inclusion of about 75% of screening colonoscopy cases; subsequent patients were included according to availability of reprocessed scopes without further selection. Group II (extracted from the Berlin screening study) was audited for completeness by comparing included patients with the coded cases during the same period, with missing cases being supplemented as far as possible.

Statistical Analysis

To test whether percentage differences between the 2 groups were statistically significant, χ^2 tests were performed. In the case of metric variables (age, etc), analysis of variance for independent groups was carried out, followed by pair-wise comparisons in the case of statistically significant main effects. When only 2 groups were compared, t tests were performed.

Results

Results concerning patient and examination data are shown in Table 1. There was only a significant difference between the 2 groups with respect to the sedation regimens, with fewer patients sedated and a lower rate of patients sedated with propofol in group I. The other parameters including endoscope withdrawal times were similar in the 2 patient groups. As shown in Table 2, ADRs (all adenomas/all patients) as well as patient rates with at least 1 adenoma were significantly higher in group I compared with group II. The percentage of small adenomas was also significantly different. There were numeric differences with respect to high-grade intraepithelial neoplasia (HGIN) lesions, but they failed to reach statistical significance, probably because of low overall numbers.

Discussion

Our study focuses on a possible effect of new endoscope technology on adenoma detection during screening colonoscopy. We used data from 2 prospective studies that were performed by the same colonoscopists, but with different equipment. In one study, endoscopists used their usual instruments consisting of different generation endoscopes from different companies, exactly mimicking daily routine and reality; none of these scopes were of the latest generation. The other study, which was primarily performed to detect differences between NBI and non-NBI imaging (but adenoma rates were exactly the same in both groups[15]), was used as example of a homogeneous switch to the most modern scope technology, in this case from one company. Both studies were prospective and were audited, and their main outcome parameter was the ADR.

Such a study design, comparison of data of 2 trials, is naturally different from a prospective randomized study com-

Table 1. Patient and Colonoscopy Data in Both Groups

	Group I (new scopes) (n = 1256)	Group II (old scopes) (n = 1400)	Significance
Patient data			
Age (*y*) (mean ± SD)	64.8 ± 7.8	64.7 ± 7.0	NS
Sex, % male	47.5	45.8	NS
Sedation			
No sedation	25.7%	14.4%	$P < .001$
Midazolam-based regimen	45.2%	37.2%	
Propofol-based regimens	29.1%	48.4%	
Mean examination time (*min*)			
Total	13.7 ± 4.1	13.8 ± 4.0	NS
Introduction	5.6 ± 2.4	5.8 ± 3.2	NS
Withdrawal	8.2 ± 3.4	8.0 ± 2.7	NS
Cecal intubation rate	99.0%	99.9%	NS

NS, not significant.

paring 2 different endoscope generations and might therefore provide a lower evidence level. On the other hand, we compared 2 large patient groups, which might counterbalance these disadvantages to some extent. Furthermore, the control group that used different older generation scopes better reflects current reality than the uniform use of one older generation endoscope. It might be a limitation of the current study that some patient characteristics that are known to influence adenoma rates, such as body mass index, smoking, and family history, were not included in the case report form of both studies. We nevertheless think that significant differences might be unlikely in 2 subsequent time periods of the same private practices, also in view of the rather large case number. Another limitation might be that bowel cleanliness was not evaluated in the new scope study part, but cases with insufficient bowel cleanliness had to be excluded. Because this was the case in 0.3% (insufficient preparation scored by the examiners) of the old scope study, we think it is unlikely that this factor might have had a major influence.

In the literature, there have been randomized studies comparing HDTV with non-HDTV colonoscopes, with patient numbers included between 300 and 600[21,22]; a recent meta-analysis showed marginal differences overall, and only the pooled weighted mean difference in small adenoma detection was better with high-definition colonoscopy ($P = .035$).[23] In this meta-analysis, 5 studies were included,[23] but only 2 were prospective and randomized; both did not show an overall increased ADR.[21,22] However, in both patient groups in both studies the video screen and probably also the processor (only specifically mentioned in one study[22]) were of the HDTV quality generation, so only the endoscopes were of different generations. This might have explained the absence of any difference. To mirror a true generation change in endoscope technology, all parts of the equipment should be changed between the groups, as was the case in our comparative analysis. Another difference in these 2 trials as well as in our study was that these latest generation instruments also have a wider angle of view. However, it was shown in another randomized trial a few years ago that wide-angle view alone does not increase adenoma detection.[11]

We decided to choose the ADR as the primary outcome parameter because this has been used in other studies[3]; also, it appears to be the most logical parameter with regard to CRC prevention,[2] and it has recently also been shown to be correlated with cancer occurrence during follow-up.[24] The effect of new technology, although demonstrable, is of unclear relevance, because the long-term clinical effect of detecting more mostly small adenomas is largely unknown. In the adenoma subgroup with the most advanced histology (HGIN), the rate was almost double in the new technology group, but because of low overall numbers, this difference was not statistically significant. Both groups of patients were comparable, with the exception of the new technology group receiving less sedation and of the sedation regimens a lower rate of propofol-based sedation. Whether this might have influenced results is difficult to say. Although studies as early as 1993 have shown that sedation leads to more complete colonoscopies,[25] more recent database analyses sug-

Table 2. Adenoma and Hyperplastic Polyp Detection Rate in the 3 Groups

	Group I (new scopes) (n = 1256)	Group II (old scopes) (n = 1400)	*P* value
Adenomas (*n*)	416	376	—
Patients with adenomas	22.1%	18.2%	<.01
ADR[a]	0.33	0.27	<.001
Adenomas <10 mm[b]	29.1	23.1	<.05
% with HGIN[b]	1.19	0.57	.06
Hyperplastic polyps (*n*)	262	206	<.01
Carcinomas (*n*)	3	5	.73

[a]All adenomas/all patients.
[b]% of all patients.

gested that deep sedation improves adenoma detection.[26,27] A recent rather large (n = 520) randomized trial could not confirm any association of the degree of sedation with polyp or adenoma detection rate.[28] Thus, it is unlikely that sedation might have had an effect; even if so, the modern generation colonoscope group had lower rates of deep (propofol) sedation but higher adenoma rates, which would be in contrast to the previous uncontrolled studies showing higher rates with deeper sedation.[26,27] The explanation for the lower rate of propofol sedation between the 2 phases might be explained by dissemination of the German sedation guidelines, which preclude use of propofol by the colonoscopist himself,[29] whereas no assistant has been specially trained for sedation, as is now the case in quite a few private practices.

Our results might be regarded as somewhat provocative in suggesting that instrument technology might have to be updated to obtain a potentially better outcome with regards to finding more precancerous lesions. Our study reflects the routine conditions in private practice in Germany for screening colonoscopy, which is almost exclusively performed outside of the hospital setting. With the German screening colonoscopy program, various instruments are in use, in most cases not of the latest generation. The program otherwise has rather high quality-control standards and includes regular audits of adenoma rates and other findings as well as regular checks of randomly selected cecal photographs. The types of instruments are naturally not controlled for, and the relatively low reimbursement for outpatient endoscopy in Germany is regarded as counterproductive to regular updates of instrument technology.

The possible conclusion that use of the newest technology leads to better outcomes in colonoscopy raises a number of related questions, for example, who should account for the economic burden of such updates, or what does an increase in ADR of 15% really mean in terms of final outcome. In the recent study by Kaminski et al,[24] different adenoma rates were correlated with the occurrence of interval cancers during follow-up. Only endoscopists with adenoma rates of 20% or more had a significantly better outcome than the 3 comparative groups with lower adenoma rates (15%–20%, 10%–15%, <10%), between whom there was no difference in outcome. Thus, an increase of 15%–20% above an adenoma rate of 20%–25% known from the German central SC registry,[30] as was shown in our comparative analysis, is still uncertain with respect to possible change of final outcomes. Nevertheless, on the basis of the above data, finding more adenomas will likely improve outcome, even if this might be to a variable extent. That such outcome improvements might also be related to instrument technology is supported by our data, which might finally have to be confirmed by the results of a randomized trial. Other factors such as examiner experience and care might also play crucial roles that have to be studied further.

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Conflicts of interest

The authors disclose no conflicts.

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