



Original Article

Prevalence of missed lesions in patients with inadequate bowel preparation through a very early repeat colonoscopy

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Objectives: When bowel preparation (BP) is inadequate, international guidelines recommend repeating the colonoscopy within 1 year to avoid missing clinically relevant lesions. We aimed to determine the rate of missed lesions in patients with inadequate BP through a very early repeat colonoscopy with adequate BP.

Methods: Post hoc analysis was conducted using data collected from a prospective multicenter randomized clinical trial including patients with inadequate BP and then repeat colonoscopy. Inadequate BP was defined as the Boston Bowel Preparation Scale (BBPS) score <2 points in any segment. We included patients with any indication for colonoscopy. The adenoma detection rate (ADR), advanced ADR (AADR), and serrated polyp detection rate (SPDR) were calculated for index and repeat colonoscopies.

Results: Of the 651 patients with inadequate BP from the original trial, 413 (63.4%) achieved adequate BP on repeat

colonoscopy. The median interval between index and repeat colonoscopies was 28 days. On repeat colonoscopy, the ADR was 45.3% (95% confidence interval [CI] 40.5–50.1%), the AADR was 10.9% (95% CI 8.1–14.3%), and the SPDR was 14.3% (95% CI 10.9–17.7%). Cancer was discovered in four patients (1%; 95% CI 0.2–2.5%). A total of 60.2% of all advanced adenoma (AA) were discovered on repeat colonoscopy. A colon segment scored BBPS = 0 had most AA (66.1%) and all four cancers.

Conclusion: Patients with inadequate BP present a high rate of AAs on repeat colonoscopy. When a colonoscopy has a colon segment score BBPS = 0, we recommend repeating the colonoscopy as soon as possible.

Key words: adenoma, bowel preparation, colonoscopy, colorectal neoplasm, polyp

INTRODUCTION

COLONOSCOPY IS THE most effective tool for detecting colorectal lesions, but it is imperfect. Some

relevant lesions might be missed, so postcolonoscopy colorectal cancer (CRC) may occur.¹ Diagnostic accuracy largely depends on the quality of bowel cleansing.² However, up to one-quarter of colonoscopies fail bowel preparation (BP).³ The risk of missing adenoma and advanced adenoma (AA) is higher in cases of inadequate BP.^{4,5} Since polyps at the index colonoscopy predict the risk of CRC in the future, detecting all lesions is critical for tailoring correct surveillance intervals. International guidelines recommend repeating the colonoscopy within 1 year

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when BP is inadequate to prevent missing clinically relevant lesions.^{6,7} Despite being a strong recommendation, the 1-year interval is arbitrary and supported by scarce evidence.

Few studies have evaluated the miss rate of colonic polyps due to inadequate BP. Chokshi *et al.*⁸ found an adenoma miss rate of 48% in repeat colonoscopy in patients with prior inadequate BP. Lebwohl *et al.*⁹ revealed adenoma and AA miss rates of 35% and 36%, respectively, on 1-year repeat colonoscopies. Of note, both studies had limitations derived from the single-center retrospective design. Inadequate BP also negatively affects the cecal intubation rate.¹⁰ Indeed, incomplete colonoscopies increase the miss rate of neoplastic lesions, including CRC, and are therefore considered a high-risk group for advanced neoplasia.^{11–13} No prospective studies have evaluated the impact of prompt referral colonoscopies in patients with complete or incomplete colonoscopies because of inadequate BP. Although one might think that a prompt colonoscopy should be recommended in these cases, more evidence is needed to clarify the relevance of missed lesions in low-quality colonoscopies.

The aim of this study was to assess the prevalence of missed neoplastic lesions in patients with inadequate BP detected in an early repeat colonoscopy.

METHODS

Study design

THIS PROSPECTIVE STUDY assessed the prevalence of missed lesions in patients with inadequate BP by early repeat colonoscopy. The study was nested in a multicenter randomized clinical trial (RCT). The scope of this study was to evaluate the benefit of an educational intervention before a repeat colonoscopy in patients with previous BP failure.¹⁴

The original study was performed between 30 January 2017 and 30 June 2018 and was conducted in 11 tertiary hospitals in Spain. The study protocol was approved by the Ethics Committee of all the centers. We followed the Declaration of Helsinki ethical guidelines and registered the study protocol at [ClinicalTrials.gov](https://clinicaltrials.gov) (NCT03055689). Written informed consent was obtained from all enrolled patients. Further information on this study can be found elsewhere.¹⁴

Study population

The initial population included consecutive outpatients aged 18–85 years with previous inadequate BP. We included patients with any indication for colonoscopy (Table 1). Exclusion criteria included severe renal impairment, active inflammatory bowel disease, and segmental or subtotal colectomy. To assess the prevalence of newly detected

Table 1 Baseline characteristics of the patients with inadequate bowel preparation on index colonoscopy and successful 6-month repeat colonoscopy

Variable	<i>n</i> = 413
Age, median (IQR), years	63.3 (53.5–69.9)
Male sex, <i>n</i> (%)	234 (56.7)
BMI, median (IQR), kg/m ²	27 (27.5–30.4)
Diabetes mellitus, <i>n</i> (%)	76 (18.4)
First colonoscopy, <i>n</i> (%)	210 (50.8)
Previous adenomas, <i>n</i> (%)	98 (23.7)
Incomplete index colonoscopy, <i>n</i> (%)	184 (44.6)
High-definition colonoscopy, <i>n</i> (%)	302 (73.1)
Indication, <i>n</i> (%)	
Screening	135 (32.7)
Surveillance	100 (24.2)
Symptoms	178 (43.1)
Period between index and repeat colonoscopy, median (IQR), days	28 (17–53)

BMI, body mass index; IQR, interquartile range.

lesions, we also excluded cases with inadequate BP at repeat colonoscopy, nonattendance, incomplete examinations for any reason other than inadequate BP, or when the elapsed time between index and repeat colonoscopies was >6 months.

All colonoscopies were performed by skilled endoscopists (>1000 colonoscopies). Before starting the study, all endoscopists underwent a calibration exercise assessing BP with the Boston Bowel Preparation Scale (BBPS) to improve consensus and minimize interobserver variability (Table S1).

BP of index colonoscopy was heterogeneous (Appendix S1), whereas the BP protocol was standardized for all repeat colonoscopies including the latest evidence-based recommendations for improving cleansing:^{6,15} (i) face-to-face visit; (ii) split-dose laxative regimen with second dose starting 5 h before colonoscopy; (iii) low-fiber diet; and (iv) nurse-led educational call for most patients (Appendix S2).

Outcome measures and definitions

The adenoma detection rate (ADR) was defined as the proportion of individuals undergoing a complete colonoscopy who had ≥1 adenomas. We analogously calculated the AA detection rate (AADR), serrated polyp detection rate (SPDR), and cancer detection rate.

We also assessed the per-lesion miss rate, calculated by dividing the number of lesions detected on repeat colonoscopy by the total number of lesions detected on both index and repeat colonoscopies.

An AA was defined by size ≥ 10 mm, to harbor high-grade dysplasia or villous histology.¹⁶ A serrated polyp was defined as any serrated lesion excluding hyperplastic polyps < 10 mm at the rectum.

“Index colonoscopy” was colonoscopy with inadequate BP, and “repeat colonoscopy” was the second examination. For the repeat colonoscopy, we considered only newly detected lesions; hence, previously detected lesions or recurrence after polypectomy were excluded.

We used the BBPS to assess the quality of BP. Endoscopists assessed the BBPS after completing all cleansing maneuvers.

According to the BBPS, each of the three segments of the colon is scored from 0 to 3, for a total BBPS score ranging from 0 to 9. When colonoscopy was incomplete due to BP, nonvisualized proximal segments were assigned a score of 0,¹⁷ including these segments in the detection rate analysis. Adequate BP was defined as BBPS segment scores ≥ 2 for all three segments of the colon. We defined proximal colon segment as proximal to the splenic flexure, meaning the combination of right and transverse colon.¹¹

Data collection

We recorded baseline variables previously reported to be associated with neoplastic colon lesions. The pathologic reports were used for histological assessment. Research electronic data capture (REDCap) was used to collect and manage data collected from the 11 hospitals.

Statistics

The qualitative variables were compared between groups by Pearson's χ^2 -test or Fisher's exact test, if applicable. Continuous variables were expressed as the means with 95% confidence intervals (CIs) and were compared using Student's *t*-test. Two-tailed $P < 0.05$ was considered statistically significant. All analyses were carried out using Stata software v. 15.1 (StataCorp, College Station, TX, USA).

Univariate and multivariable analyses were performed to determine the association between the presence of AA on repeat colonoscopy with any condition at index colonoscopy.

RESULTS

Patient characteristics

OF THE 651 patients with inadequate BP, 66 patients were excluded due to segmental or subtotal colectomy. We excluded 41 patients for nonattendance, 14 patients for

incomplete colonoscopy, and 103 patients for inadequate BP on repeat colonoscopy. In addition, 14 patients were also excluded due to an elapsed time between colonoscopies > 6 months. Finally, 413 patients were analyzed (Fig. 1).

The overall median age was 63.3 years (interquartile range 53.5–69.9), 57% were men, and one-third of patients were undergoing screening colonoscopies. Importantly, 45% of patients had incomplete index colonoscopies due to very poor BP. Half of the colonoscopies were repeated in < 1 month (median 28 days; Table 1).

Bowel preparation

The mean BBPS score was 2.3 points (standard deviation [SD] 1.8) at index colonoscopy. At repeat colonoscopy, the mean BBPS score was substantially improved, reaching 7.1 points (SD 1.2; Table 2).

Detection rates

At index colonoscopies, the ADR was 22% (95% CI 18.1–26.3%), the AADR was 7.5% (95% CI 5.2–10.5%), and the SPDR was 3.6% (95% CI 2–4.1%). Cancer was detected in two patients (0.5%; 95% CI 0.1–2%).

At repeat colonoscopy, the ADR was 45.3% (95% CI 40.4–50.2%), the AADR was 10.9% (95% CI 8.1–14.3%), and the SPDR was 14.3% (95% CI 11.1–18%). CRC was

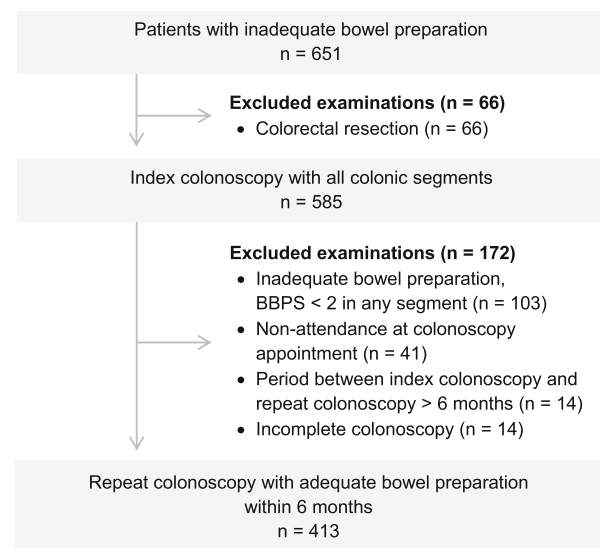


Figure 1 Flow chart of the study. Of the 651 patients with inadequate bowel preparation from the original trial, 413 (63.4%) achieved adequate bowel preparation on repeat colonoscopy.

Table 2 Bowel preparation on the index and repeat colonoscopies

Variable	Index colonoscopy, <i>n</i> = 413	Repeat colonoscopy, <i>n</i> = 413
Total BBPS score, mean (SD)	2.3 (1.8)	7.1 (1.3)
Proximal colon BBPS score, mean (SD)	0.7 (0.6)	2.3 (0.4)
Distal colon BBPS score, mean (SD)	0.9 (0.7)	2.4 (0.5)
Segmental BBPS score, <i>n</i> (%)		
Right colon		
BBPS score = 0	204 (49.4)	0 (0.0)
BBPS score = 1	181 (43.8)	0 (0.0)
BBPS score = 2	27 (6.5)	294 (71.2)
BBPS score = 3	1 (0.2)	119 (28.8)
Transverse colon		
BBPS score = 0	163 (39.5)	0 (0.0)
BBPS score = 1	181 (43.8)	0 (0.0)
BBPS score = 2	68 (16.5)	248 (60)
BBPS score = 3	1 (0.2)	165 (40)
Left colon		
BBPS score = 0	119 (28.8)	0 (0.0)
BBPS score = 1	208 (50.4)	0 (0.0)
BBPS score = 2	77 (18.6)	250 (60.5)
BBPS score = 3	9 (2.2)	163 (39.5)

Note: Proximal colon refers to proximal to the splenic flexure, meaning the mean of the right and transverse colon. Distal colon corresponds to left colon segment.

BBPS, Boston Bowel Preparation Scale; SD, standard deviation.

discovered in four patients (1%; 95% CI 0.2–2.5%; Table 3).

The per-adenoma miss rate was 68.9% (95% CI 65–72.6%), with 186 adenomas found at index colonoscopy and 412 at repeat colonoscopy. The per-AA miss rate was 60.2% (95% CI 50–70.2%), with 37 AA found at index colonoscopy and 56 at repeat colonoscopy. The per-serrated polyp miss rate was 83.8% (95% CI 76.4–89.7%), with 21 serrated polyps found at index colonoscopy and 109 at repeat examination. The per-cancer miss rate was 66.7% (95% CI 22.3–95.8%), with two cancers detected at index colonoscopy and four at repeat examination. All four CRC were missed in incomplete index colonoscopies (Table 4).

Lesion location and per-segment analysis

At index colonoscopy, a higher proportion of lesions was detected in the distal colon than in the proximal colon. In contrast, at repeat colonoscopy most lesions were detected

Table 3 Detection rates on the index and repeat colonoscopies

Variable	Index colonoscopy, <i>n</i> (%) [95% CI]	Repeat colonoscopy, <i>n</i> (%) [95% CI]
Adenoma detection rate	91 (22) [18.1–26.3]	187 (45.3) [40.4–50.2]
Advanced adenoma detection rate	31 (7.5) [5.2–10.5]	45 (10.9) [8.1–14.3]
≥3 adenomas detection rate	23 (5.6) [3.6–8.2]	51 (12.3) [9.2–15.9]
≥5 adenomas detection rate	9 (2.2) [1.0–4.1]	23 (5.6) [3.6–8.2]
Serrated polyp detection rate	15 (3.6) [2–5.9]	59 (14.3) [11.1–18.0]
Colorectal cancer detection rate	2 (0.5) [0.1–2.0]	4 (1) [0.3–25.0]

Note: 95% confidence interval (CI) calculated using the Clopper–Pearson method.

in the proximal colon (Table 4). In accordance with these results, the missed rates were higher in the proximal colon than in the distal colon for adenoma (73% vs. 64%), AA (72% vs. 46%), and CRC (100% vs. 33.3%).

Lesion detection and bowel preparation

We analyzed the findings of the repeat colonoscopy stratified by BP of the colon segment at index colonoscopy (Table 5). Patients were classified into three categories by the BBPS colon segment: inadequate (BBPS = 0), suboptimal (BBPS = 1), and adequate (BBPS >1).

An index colonoscopy with a BBPS = 0 in the distal colon revealed a significantly higher AADR (odds ratio [OR] 9.5; *P* < 0.01) at repeat colonoscopy compared with a BBPS = 1.

As shown in Table 5, the per-adenoma and AA miss rate were strongly associated with BP at index colonoscopy. An index colonoscopy with a segmental BBPS = 0 compared with a BBPS >1 revealed a significantly higher per-adenoma miss rate (OR 22.6; *P* < 0.001) and per-AA miss rate (OR 50; *P* = 0.02) in the proximal colon. Similarly, a significantly higher per-adenoma miss rate (OR 83.1; *P* < 0.001) and per-AA miss rate (OR 156; *P* < 0.001) were found in the distal colon.

An index colonoscopy with BBPS = 1 in distal colon revealed a significantly higher per-adenoma miss rate (OR

Table 4 Per-lesion miss rates and location

Location	Index colonoscopy n (%)	Repeat colonoscopy n (%)	Miss rate (95% CI)
Adenomas	186 (100)	412 (100)	68.9% (65.0–72.6)
Proximal colon	88 (47.3)	238 (57.8)	73% (67.8–77.7)
Distal colon	98 (52.7)	174 (42.2)	63.9% (57.9–69.8)
Advanced adenomas	37 (100)	56 (100)	60.2% (50–70.2)
Proximal colon	14 (37.8)	36 (64.3)	72 (57.5–83.8)
Distal colon	23 (62.2)	20 (35.7)	46.5 (31.2–62.4)
Serrated polyp	21 (100)	109 (100)	83.8% (76.4–89.7)
Proximal colon	12 (57.1)	59 (54.1)	83.1 (72.3–90.9)
Distal colon	9 (42.9)	50 (45.9)	84.7 (73–92.8)
Cancer	2 (100)	4 (100)	66.7% (22.3–95.8)
Proximal colon	0 (0)	3 (75)	100% (29–100)
Distal colon	2 (100)	1 (25)	33.3% (0.8–90.6)

Note: 95% CI calculated using the Clopper–Pearson method. CI, confidence interval.

3.6; $P < 0.001$) and per-AA miss rate (OR 10.1; $P = 0.04$) on repeat colonoscopy compared with BBPS > 1 .

Factors associated with the presence of AA on repeat colonoscopy

Multivariable analysis showed that patients ≥ 70 years (adjusted OR 2.95; 95% CI 1.5–5.7; $P < 0.001$) and having a segmental BBPS = 0 at index colonoscopy (adjusted OR 4.45; 95% CI 1.6–11.7; $P = 0.003$) were associated with a significantly increased risk of AA at repeat colonoscopy (Table 6).

DISCUSSION

THIS PIONEERING PROSPECTIVE multicenter study revealed that patients with inadequate BP presented a high rate of missed adenoma, AA, serrated lesions, and CRC. A complete colonoscopy with poor BP was valid for ruling out CRC but did not prevent missing AA, which were highly prevalent when a colonic segment was scored BBPS = 0. Our data underline the importance of achieving

a high-quality colonoscopy to avoid missing clinically relevant lesions.

Our study revealed that missed adenomas are more frequent than previously reported, with an ADR of 45% and AADR of 11% in repeat colonoscopy. The per-adenoma and per-AA miss rates were 69% and 60%, respectively. We believe these findings are very relevant, as AA may transform into CRC before the 1-year repeat colonoscopy recommendation.¹⁸ Previous studies have evaluated the association between BP and missed lesions. A large meta-analysis of tandem colonoscopies showed 26% missed adenomas and 9% missed AA.¹⁹ However, most tandem studies enrolled only patients with successful BP. In retrospective studies of repeated colonoscopy due to inadequate BP, the per-adenoma miss rate ranged from 35% to 48%, and the per-AA miss rate was 36% in the 1-year repeat colonoscopy. However, only a small subset of their original population (9% and 35%, respectively) underwent a repeat examination, which might constitute a strong selection bias.^{8,9} A recent observational study in a screening population showed an AADR of 14.9% and a per-AA miss rate of 17.6%, but patients with index colonoscopy with any segmental score BBPS = 0 or incomplete examinations were excluded.²⁰ Unlike the aforementioned studies, ours included most patients in the initial sample (63.4%), regardless of the BBPS score.

We found an SPDR of 14.3%, most of them detected on repeat colonoscopy (84%). There is scarce evidence of missed serrated lesions due to poor BP.^{21,22} Our results are supported by Clark *et al.*, who showed that SPDR was lower when total BBPS was < 7 points compared with BBPS of 7–9 points (4.7% vs. 12.6%).²³

We found that colonoscopies with the lowest quality hid the most worrisome lesions. Indeed, four CRC were missed and detected on repeat colonoscopy. In all cases, the index colonoscopy was incomplete because of poor BP. No prospective study has evaluated the importance of early repeat colonoscopy, including these incomplete examinations, so the frequency of missed carcinoma cases remains unknown.⁴ Our data suggest that CRC detection may be undermined by unexplored areas of the colon.

BP is crucial for detecting lesions. The substantial difference in total BBPS scores between index and repeat colonoscopy could explain our high miss rate. This difference was because all index colonoscopies had inadequate BP (44% were incomplete), while all repeat colonoscopies had adequate BP. The best approach for patients with previous failed BP is unclear. The next regimen should be individualized according to the possible reasons for failure. Educational strategies such as our nurse-led call may

Table 5 Findings on repeat colonoscopy depending on the bowel preparation of the segment on the index colonoscopy: adequate (BBPS >1) vs. suboptimal (BBPS = 1) vs. inadequate (BBPS = 0)

	BBPS	n	OR (95% CI)	P-value	Miss rate	OR (95% CI)	P-value
Adenoma							
Proximal colon	0	61	0.8 (0.3–2.6)	0.78	113/122 (92.6%)	22.6 (6.2–81.9)	<0.001
	1	62	0.9 (0.3–2.9)	1.00	119/189 (63.0%)	3.1 (1–9.5)	0.051
	>1	5	–	–	5/14 (35.7%)	–	–
Distal colon	0	38	1.5 (0.8–2.9)	0.21	68/69 (98.6%)	83.1 (11.1–622)	<0.001
	1	53	1.1 (0.6–2.0)	0.77	124/166 (74.7%)	3.6 (2.1–6.1)	<0.001
	>1	20	–	–	45/55 (45.0%)	–	–
Advanced adenoma							
Proximal colon	0	17	1.3 (0.2–10.3)	1.00	25/26 (96.2%)	50 (2.2–1137)	0.020
	1	9	0.7 (0.1–5.8)	0.54	10/21 (47.6%)	1.8 (0.1–23.3)	1.000
	>1	1	–	–	1/3 (33.3%)	–	–
Distal colon	0	12	9.5 (1.2–74.8)	<0.01	12/13 (92.3%)	156 (8.8–2781)	<0.001
	1	5	2.1 (0.2–18.2)	0.68	7/16 (43.9%)	10.1 (1.1–97)	0.040
	>1	1	–	–	1/14 (7.1%)	–	–
Serrated polyp							
Proximal colon	0	17	1.3 (0.2–10.2)	1.00	26/26 (100%)	–	–
	1	23	1.9 (0.2–15.1)	1.00	31/42 (73.8%)	1.4 (0.1–17.1)	1.000
	>1	1	–	–	2/3 (66.7%)	–	–
Distal colon	0	6	0.5 (0.2–1.3)	0.18	12/12 (100%)	–	–
	1	15	0.7 (0.3–1.6)	0.36	25/29 (86.2%)	2.4 (0.5–10.5)	0.270
	>1	9	–	–	13/18 (72.2%)	–	–
Cancer							
Proximal colon	0	3	–	–	3/3 (100%)	–	–
	1	0	–	–	–	–	–
	>1	0	–	–	–	–	–
Distal colon	0	1	–	–	1/2 (50%)	–	–
	1	0	–	–	–	–	–
	>1	0	–	–	0/1 (0%)	–	–

– [define]; BBPS, Boston Bowel Preparation Scale; CI, confidence interval; OR, odds ratio.

Table 6 Factors associated with the presence of advanced adenomas on repeat colonoscopy

	Univariate		Multivariate	
	OR (95% CI)	P-value	OR (95% CI)	P-value
Index colonoscopy with a colon segment BBPS = 0	2.62 (0.3–1.67)	0.006	4.4 (1.6–11.7)	0.003
Age ≥70 years	2.96 (0.44–1.73)	0.001	2.9 (1.5–5.7)	0.001
Sex (male)	1.01 (–0.62–0.65)	0.980	1.1 (0.6–2.2)	0.760
Body mass index	0.95 (–0.12–0.02)	0.170	0.9 (0.9–1)	0.120
Diabetes mellitus	0.82 (–1.13–0.6)	0.650	0.6 (0.2–1.4)	0.260
Previous adenomas	1.4 (–0.39–1.01)	0.340	2 (0.8–5.2)	0.140
First colonoscopy	0.71 (–0.9–0.29)	0.230	0.8 (0.4–1.5)	0.450
Incomplete index colonoscopy	0.64 (–1.09–0.18)	0.160	2.2 (0.8–5.4)	0.090
Screening colonoscopy	0.96 (–0.74–0.61)	0.900	1.8 (0.8–3.8)	0.150
High-definition colonoscopy	0.91 (–0.81–0.7)	0.810	1 (0.5–2.3)	0.920

BBPS, Boston Bowel Preparation Scale; CI, confidence interval; OR, odds ratio.

improve BP, especially in case of poor adherence. In case of impaired bowel peristalsis, more intensive regimens have been suggested.⁶

Another important result of the present study was the significant association between the quantitative score measured by the BBPS of the colon segments at index colonoscopy and AADR. AADR was higher in the distal colon in patients with BBPS = 0 than in those with BBPS = 1. In addition, a segmental BBPS = 0 at index colonoscopy dramatically increased the risk of missing adenomas and AA at repeat colonoscopy compared with segment scored BBPS = 1.

There is no agreement on the definition of adequate BP.²⁴ In the present study, we did not find significant differences in ADR or AADR at repeat colonoscopy between patients with segmental BBPS = 1 and BBPS >1 at index colonoscopy. However, a relevant proportion of AA lesions were missed in patients with segmental BBPS = 1 compared with those with BBPS >1. Therefore, we consider that the per-lesion miss rate could be a better indicator to measure the postcolonoscopy risk of CRC than the lesion detection rate. Thus, this study supports the current guidelines that recommend achieving at least a BBPS = 2 per-segment.⁶

Clark *et al.*,⁵ in a single-center study carried out in veterans, showed that colon segments with a BBPS score of 1 had a significantly higher rate of missed adenomas >5 mm than segments with scores of 2 or 3. According to the present study, Baile-Maxia *et al.* failed to show differences in the ADR between segments with BBPS = 1 compared with BBPS >1 in patients with positive fecal immunochemical test and only found a significant increase in the AADR in the left colon. However, the aforementioned studies have several flaws. First, BBPS = 0 was underrepresented compared with BBPS ≥1 patients.^{5,20} Second, both were single-center studies,^{5,20} and the number of detected lesions on repeat colonoscopy was fairly low to detect significant differences in missed AA.⁵ Third, participants may not be representative of the general population.⁵ Finally, one of the studies had the inherent limitations of its retrospective design.²⁰ Our study seems to solve these limitations, given its multicenter nature, the significant representation of BBPS = 0 patients, and being nested in the RCT.¹⁴

Multivariable analysis showed that patients ≥70 years (adjusted OR 2.95) and having a segment colon BBPS = 0 at index colonoscopy (adjusted OR 4.45) were associated with a significantly increased risk of AA at repeat colonoscopy. These patients with an unprepared colon might be considered a high-risk group of missed clinically relevant lesions. These results are coherent with other studies.¹¹

This study strengthens the idea that a high-quality colonoscopy must be considered an essential prerequisite

to recommend the correct interval for postpolypectomy surveillance. Inadequate BP includes a wide range of BBPS scores, from 0 to 7. Remarkably, this spectrum of BP is considered at the same level of inadequacy, and 1-year repeat colonoscopy is recommended.^{6,7} However, our results suggest that 1 year may be too long for those patients with the worst BP (BBPS = 0). Our study showed that two-thirds of AA and all CRCs were found in a colonoscopy with an unvisualized colonic segment at index colonoscopy due to inadequate BP and incomplete procedures, respectively. We recommend repeating the colonoscopy as soon as possible in patients with any colonic segment BBPS = 0.

Our study has several strengths. First, it is the first prospective multicenter study that quantifies the prevalence of missed lesions because of inadequate BP. Second, we included patients with any indication for colonoscopy, allowing a better generalization of our results. Third, unlike other studies, the interval between index and repeat colonoscopy was very short, with a median of 28 days, increasing the degree of certainty that we are facing true missed lesions. Finally, our prospective study is pioneering for assessing the prevalence of missed lesions in patients with very poor BP (BBPS = 0).

We are also aware of the limitations of the study. First, the categorization of the lesion by location (proximal or distal) prevented us from stating a precise correlation with the segmental BBPS assessment. Second, our results come from a post-hoc analysis with limited statistical power. However, this study was nested in a well-powered multicenter RCT. Third, lesions' size and morphology were not recorded. Fourth, we did not register the withdrawal time, but a minimum of 6 min was required for all complete colonoscopies.

In conclusion, inadequate BP truly compromises the effectiveness of the colonoscopy, given the high proportion of missing AA found in the repeat colonoscopy after achieving adequate BP. Patients with any colonic segment BBPS = 0 should be considered the highest group of risk of missing relevant lesions and may benefit from repeating the colonoscopy as soon as possible.

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CONFLICT OF INTEREST

AUTHOR M.A.A.-G. HAS received honoraria for advisory board attendance, speaking and teaching from Norgine Ltd, and for speaking and teaching from Casen-Recordati. The other authors declare no conflict of interest for this article.

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Table S1 Characteristics of bowel preparation of index colonoscopies.

Appendix S1 Bowel preparation of index colonoscopies.

Appendix S2 Bowel preparation protocol of repeat colonoscopies.

SUPPORTING INFORMATION

ADDITIONAL SUPPORTING INFORMATION may be found in the online version of this article at the publisher's web site.