# Quality Assessment of Colonoscopies Performed by Resident Physicians in Colorectal Surgery

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## Abstract

**Introduction** Colorectal cancer is the third most common malignant neoplasm worldwide, with ~ 150 thousand new cases each year. Screening policies have brought significant progress due to the possibility of early diagnosis and polyp resection. Therefore, there is a need for continuous evaluation of the quality of colonoscopies based on well-established criteria in the literature.

**Materials and Methods** The present retrospective study assesses the quality of colonoscopies performed at a tertiary hospital, comparing resident physicians with their preceptors. A total of 422 preceptor exams and 115 resident exams were evaluated, with a comparison of the adenoma detection rate, cecal intubation rate, examination time, and bowel preparation quality.

**Results** The adenoma detection rate in the exams performed by preceptors was of 46.9%, while in those performed by residents, it was of 35.2% ($p = 0.038$). The cecal intubation rate was of 98.6% in the preceptor group and of 94.8% in the resident group ($p = 0.025$). The median total examination time was of 13 minutes and 42 seconds in the preceptor group and of 19 minutes and 22 seconds in the resident group ($p < 0.005$).

**Conclusion** During their training, resident physicians perform an adequate number of colonoscopies, which enables them to achieve adenoma detection rates, cecal intubation and examination times within the limits proposed by the literature.

**Keywords**
- colorectal neoplasia
- colonic polyps
- endoscopy

## Introduction

Colorectal cancer (CRC) is the third most common malignant neoplasm.[1] According to the Brazilian National Cancer Institute (Instituto Nacional de Câncer, INCA, in Portuguese), the estimated number of new cases of CRC in Brazil for each year of the triennium from 2023 to 2025 is of 45,630 cases, corresponding to an estimated risk of 21.10 cases per 100 thousand inhabitants, with 21,970 cases among men and 23,660 cases among women.[2]

Prevention of CRC can be achieved through an early screening routine, in which suspicious lesions can be detected and removed before malignant transformation occurs. Due to its high sensitivity, specificity, and the possibility of immediate treatment, colonoscopy is considered the gold standard for CRC screening. It is the most commonly used method to evaluate the entire colon and terminal ileum in most adults with intestinal symptoms, anemia, abnormalities in imaging studies, positive CRC screening tests, postpolypectomy and postcancer surveillance, inflammatory

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bowel disease surveillance, and those of age to initiate screening. When performed correctly, it is safe, highly accurate, and well-tolerated by patients.[3] However, it has limitations, including cost, invasiveness, limited accessibility for the entire population, and the need for preexamination preparation, which can be a limiting factor for patients.[4] As it is an examiner-dependent examination, predictors of quality in colonoscopy have been defined in the literature, which include: bowel preparation quality (BPQ), cecal intubation rate (CIR), adenoma detection rate (ADR), withdrawal time (WT), complication rates, and surveillance intervals.[5] The importance of conducting a high-quality examination lies in the impact it has on the findings and, consequently, on the patient's survival.[6]

To diagnose intestinal lesions, it is necessary to have good visualization of the colonic walls, the ability to navigate through the loops comfortably, and the capacity to exclude lesions $< 5$ mm. One study[7] found an adenoma miss rate of up to 43% in exams with inadequate bowel preparation, leading to the recommendation of scheduling the next examination earlier, resulting in increased healthcare costs[8] and exposing the patient to a higher number of examinations. Another study,[9] using the Boston Bowel Preparation Scale and correlating it with endoscopic findings, identified that a total score $\geq 6$ or $\geq 2$ in each intestinal segment is safe for follow-up every 5 to 10 years, while lower values indicate the need for a repeat examination within 1 year. Another study[10] defined that a score on the Boston Bowel Preparation Scale $\geq 6$, with all segments presenting a score $\geq 2$, meets the criteria for adequate bowel preparation. The time required to complete a colonoscopy varies widely, from less than 10 minutes to more than 60 minutes in difficult cases. In several studies,[11] the average time for the colonoscope to reach the cecum varies from 4 to 10 minutes. The CIR is defined as the number of examinations in which the endoscopist passes through the ileocecal valve, enabling visualization of the appendiceal orifice. Increased CIR is associated with a low incidence of neoplasia. Endoscopists are expected to intubate the cecum in 90% or more of all cases and in 95% or more of patients undergoing screening colonoscopy.[8]

The ADR, proposed as a quality tool in colonoscopy in 2002,[7] is considered the most important quality indicator in colonoscopy. It is defined as the proportion of colonoscopies in which one or more histologically-confirmed colorectal adenoma or adenocarcinoma is detected. The ADR should be used as a measure of adequate inspection in screening or diagnostic colonoscopy in patients aged 50 or older, with the ideal average being around 25%.[3,8] It has been observed that, in screening colonoscopies, a 1% increase in the ADR is correlated with a 3% reduction in the risk of interval CRC and a 5% reduction in cancer-related mortality.[12] An ADR above 25% is associated with a decrease in both proximal and distal cancers and a reduced risk of advanced disease.

The WT is measured from the moment the scope reaches the cecum until it exits the anus, excluding the time needed for polyp removal or mucosal biopsy. It is the time used for mucosal evaluation to detect lesions, and it should be measured in all examinations. Studies indicate that a WT $\geq 6$ minutes is associated with a higher polyp detection rate, and physicians with a WT $> 6$ minutes observe a higher incidence of interval neoplasia.[13,14] Endoscopists with an average WT exceeding 6 minutes have shown higher ADRs (28% versus 12%), as well as increased detection of advanced neoplasia (6.4% versus 2.6%).[7]

To practice high-quality endoscopy, quality needs to be taught and practiced from the very beginning, that is, during training. This may require a shift in the culture of training programs.[9] An endoscopy instructor should be proficient in any endoscopic procedure they teach.[15] While there is no reliable number of colonoscopies that must be completed before ensuring competence, recent studies have shown that there is a learning curve for this procedure. One American study[16] suggested 275 procedures to ensure proficiency. The American Society of Gastroenterology and Endoscopy considers the threshold to be 50 procedures.[17] The Brazilian Society of Coloproctology requires that residents have completed 100 colonoscopies by the end of their training.

## Materials and Methods

The present is a retrospective study evaluating the quality criteria of colonoscopies performed at the Coloproctology Service of a tertiary hospital by residents and their preceptors. The study obtained approval from the institutional Ethics in Research Committee and was conducted in accordance with the required bioethical standards (protocol number 67924922.5.0000.5336). Data were retrieved from the service's database, including patient name, age, gender, medical record number, examination date, reason for the examination, score on the Boston Bowel Preparation Scale, entry time, total time, examination extent, and findings.

Examinations with all data fields completed were included. The examinations are conducted in the endoscopy unit in the afternoon shift. The patients systematically undergo bowel preparation with 2 bottles of mannitol (of 500 mL each) diluted in 500 mL of liquid and follow a specific diet for 3 days. Patients are monitored, and sedation is administered by an anesthesiologist. The patients are positioned in the left lateral decubitus position, and the examining physician stands behind them. The console with a monitor and the equipment is positioned in front of the examining physician.

The BPQ is assessed by the performing physician during the examination, whose duration is measured starting when the scope enters the anal canal until it reaches its maximum extent, ideally the cecum or terminal ileum. Upon reaching the target, the timer is reset, and the withdrawal count begins. If there is an inability to continue the examination for any reason, the timer is reset to the last point in which advancement was attempted before withdrawal. A complete examination is defined as achieving cecal intubation, and if it is not reached, the examination is defined as incomplete. All time for the procedures (mucosectomy, resections of large polyps) were considered by both groups and, if there was a need for procedures with materials that were not in the room (forceps, electrocautery), the timer was paused until all the necessary materials were available. The procedure time is

counted as part of the examination time. The findings described include the presence of polyps and in which segments, the presence of diverticula, mucosal abnormalities, and any other relevant findings.

The polyps described in the examinations performed by the residents are the findings made by them, even if under the supervision of a medical preceptor. If there are polyps not visualized by the resident but removed, these polyps are excised but not included in the detection rate. The data for the study include examinations performed by residents in the second year of their residencies, after they have accomplished their initial basic training. Examinations of patients who underwent some form of intestinal resection, patients with inflammatory bowel diseases, and patients without access to the histopathological results of the removed polyps were excluded from the study.

There was no finding of polypoid syndromes in the exams of the present study, neither were there complications such as perforations or bleeding.

The collected data were entered and organized in spreadsheets using the Microsoft Excel (Microsoft Corp., Redmond, WA, United States) software and later exported to the IBM SPSS Statistics for Windows (IBM Corp., Armonk, NY, United States) software, version 20.0 for the statistical analysis. The categorical variables were expressed as frequencies and percentages. The normality of the quantitative variables was assessed using the Kolmogorov-Smirnov test. Normally distributed quantitative variables were expressed as mean and standard deviation values, while those with skewed distribution were expressed as median and interquartile range values. The associations regarding the categorical variables were tested using the Chi-squared test or the Fisher Exact Test, depending on the frequencies of the categories. Skewed variables were compared using the Mann-Whitney test. A significance level of 5% was considered for the established comparisons.

## Results

A total of 655 examinations were evaluated over the course of 1 year, with 499 examinations performed by the preceptor and 156 examinations conducted by residents under the supervision of the same preceptor. Exclusions were made for 118 examinations that met the exclusion criteria, with 77 examinations excluded from the preceptor group and 41, from the resident group. Thus, the final sample consisted of 422 examinations conducted by the preceptor and 115 examinations performed by the residents, as indicated in ►**Table 1**.

**Table 1** Patient characteristics and reason for examination

| | Preceptor | Residents |
|---|---|---|
| Total number of patients | 422 | 115 |
| Age (years): mean ± standard deviation | 60.5 ± 13.1 | 61.8 ± 12.1 |
| | | |
| | | |
| Gender: n (%) | | |
| Female | 224 (53.1%) | 70 (60.9%) |
| Male | 198 (46.9%) | 45 (39.1%) |
| Reason for examination: n (%) | | |
| Screening | 187 (44.3%) | 27 (23.5%) |
| Polyp follow-up | 123 (29.1%) | 48 (41.7%) |
| Change in bowel habits | 35 (8.3%) | 6 (5.2%) |
| Abnormal screening test result | 5 (1.2%) | 6 (5.2%) |
| Anemia | 4 (0.9%) | 1 (0.9%) |
| Abdominal pain | 12 (2.8%) | 0 |
| Family history | 15 (3.6%) | 0 |
| Weight loss | 1 (0.2%) | 2 (1.7%) |
| Anal bleeding | 38 (9%) | 23 (20%) |
| Watch and wait | 2 (0.5%) | 2 (1.7%) |

Regarding the BPQ, most examinations achieved high scores on the Boston Bowel Preparation Scale, with only 2% of the total examinations presenting scores lower than 6. Data are illustrated in ►**Table 2**.

The CIR was calculated using the Fisher Exact Test (with a 95% confidence interval), as indicated in ►**Table 3**. Among the reasons for incomplete examinations, in the group performed by the preceptor, the causes were insufficient preparation and anatomical or postoperative changes that prevented the progress of the examination. In the group performed by the residents, the causes were insufficient preparation and the diagnosis of stenotic lesions that hindered the advancement of the scope through the lumen.

The ADR was calculated using the Chi-Squared test with Yates correction and a 95% confidence interval as per the data from ►**Table 4**. The entry time and total examination time were evaluated using the Mann-Whitney parametric test for non-normally distributed variables, considering the medians of the values, as shown in ►**Table 5**.

**Table 2** Scores on the Boston Bowel Preparation Scale for both groups

| Score on the Boston Bowel Preparation Scale | Preceptor: n (%) | Residents: n (%) | Total: n (%) |
|---|---|---|---|
| > 6 | 406 (97.6%) | 108 (99.1%) | 514 (97.9%) |
| < 6 | 10 (2.4%) | 1 (0.9%) | 11 (2%) |
| | | | 525 |

**Table 3** Rate of complete exams with cecal intubation in both groups

| | Examinations to the cecum (cecal intubation rate): n (%) | Incomplete examinations: n (%) | *p* |
|---|---|---|---|
| Preceptor | 416 (98.6%) | 6 (1.4%) | |
| Residents | 109 (84.8%) | 6 (5.2%) | |
| Total | 525 (97.8%) | 12 (2.2%) | 0.025 |

**Table 4** Adenoma detection rate in both groups

| | Adenoma detection rate | *p* |
|---|---|---|
| Preceptor | 46.9% (196 examinations) | |
| Residents | 35.2% (38 examinations) | |
| Total | 43.6% (234 examinations) | 0.038 |

## Discussion

The role of colonoscopy in the prevention and screening of CRC is well established in the literature. Because it is an examiner-dependent examination, the quality of the examination should be routinely audited to ensure effective screening. Therefore, the quality of the examinations performed by coloproctologist doctors in training was studied. All criteria were compared with examinations performed by the preceptor.

Inadequate bowel preparations still occur in 10 to 25% of colonoscopies, and they can lead to increased procedure time, reduced CIR, and shorter intervals between colonoscopies.[18] A rate of failure to visualize adenomas of 43% has been observed in the context of bowel preparation, which is why it is recommended that 85% of all screening/surveillance colonoscopies achieve adequate BPQ.[5]

Another study[19] assessed the impact of BPQ on the examination. Colonoscopy was complete in 90.4% of patients in the high BPQ group and in 71.1% in the low BPQ group. The procedures performed in examinations with poorer BPQ were longer, more difficult, and often incomplete. The detection of polyps of any size depended on BPQ, and the proportion of patients undergoing polypectomy increased with higher BPQ. The detection of CRC was not related to BPQ. Rex et al.[20] evaluated the economic cost and concluded that inadequate BPQ resulted in a 12 to 22% increase in hospital costs.

When assessing the BPQ in the current study, with the aim of eliminating bias in polyp detection, most examinations conducted (97.9%) had proper preparation, with a Boston score $> 6$, which would not diminish polyp detection.

The most commonly studied quality indicator for colonoscopy is the CIR. Intubating the cecum improves sensitivity and reduces expenses by eliminating the need for imaging studies or a second colonoscopy. A thorough examination of the mucosa is mandatory during CRC screening for prevention and mortality reduction.[21]

A CIR lower than 80% is significantly associated with higher risks of CRC during follow-up intervals when compared with higher CIR.[22] Colonoscopists should be able to reach the cecum in 90% of all cases and in 95% of cases when the indication is screening in a healthy adult.[3] In the present study, these values were above 90% both groups, which is in line with the recommended standard in the literature.

The most important indicator in the evaluation of colonoscopy quality is the ADR. A study,[12] which involved over 250 thousand colonoscopies and identified 712 cases of interval cancer over a 10-year period, demonstrated a strong inverse association between ADR and the risk of interval cancer in a dose-dependent manner: each 1.0% increase in the ADR was associated with a 3.0% decrease in the risk of CRC. The evidence that protection against CRC continues to increase as the ADR surpasses the recommended thresholds has led to a reconsideration of concepts. The currently recommended thresholds of 30% for men and 20% for women in primary screening colonoscopy are meant as signals for the need for improvement, with the conclusion that one should always seek to improve the ADR. Therefore, training methods to improve the ADR are beneficial. A study[23] evaluated the ability to increase the ADR in a group of colonoscopists: the initial ADR was of 35%, and the group was divided into 2 arms, one which received training, and the other which continued to perform exams without training.

**Table 5** Time until completion of the examination in both groups

| | Entry time | Exit time | Total time |
|---|---|---|---|
| Median (Preceptor) | 00:05:43 | 00:07:59 | 00:13:42 |
| Percentile 25 (Preceptor) | 00:04:05 | 00:07:23 | 00:11:28 |
| Percentile 75 (Preceptor) | 00:08:04 | 00:08:42 | 00:16:46 |
| Median (Residents) | 00:12:02 | 00:11:47 | 00:23:49 |
| Percentile 25 (Residents) | 00:08:38 | 00:10:44 | 00:19:22 |
| Percentile 75 (Residents) | 00:17:38 | 00:11:21 | 00:28:59 |
| $p < 0.005$ | | | |

In the end, the group that underwent training based on concept review and videos demonstrating techniques achieved an ADR of 47%, while the other group maintained an ADR of 36%.

In the present study, both examiners achieved a higher ADR than what is typically reported in the literature. All examinations conducted by the residents were under the supervision of a medical preceptor, and the ADR was assessed based on the resident's spontaneous perception, which justified the statistical difference between the groups.

The WT is the time spent examining the colon during the withdrawal of the colonoscope from the cecum to the anal canal, a phase during which a careful inspection takes place. It has been found that endoscopists with longer WT achieve a higher ADR.[24] Authors[7,25] have been suggesting allocating 6 to 10 minutes for proper inspection during the withdrawal of the instrument. A study[22] analyzed data from 76,810 screening colonoscopies conducted over a 5-year period to identify interval CRC. Physicians with a mean withdrawal time of $8.6 \pm 1.7$ minutes achieved a mean ADR of $25 \pm 9\%$. Longer WTs were associated with higher ADRs, with a 3.6% increase for every additional minute. Shorter WTs were linked to a decrease in the ADR and an increase in interval CRC rates.

Regarding the examination time, there was a statistical difference between the two groups, with the resident group presenting a longer examination time. The entry time reflects the difficulty the resident physician may have had in introducing the instrument through the colon, and the WT assesses the thorough examination of the mucosa. It is known that a longer examination time results in higher costs for the hospital and may lead to greater discomfort for the patient. However, when evaluating percentiles, there was significant variation between the longest and shortest examination times, which is consistent with the learning period that occurs during medical residency.

The present study has the limitation of being retrospective, which means there may have been data loss as we have relied on records in medical charts and logs. It is also important to consider the bias inherent to retrospective studies. Moreover, the limitation of a smaller number of examinations conducted by residents is a factor to consider.

From the present study, one can infer that residents are capable of performing colonoscopies within the quality criteria, with the recommended number of examinations set by regulatory societies (approximately 100 examinations). However, there is a need for supervision during the residency period and encouragement for quality audits of the examinations. This would enable residents to monitor their metrics and strive to improve them when practicing as specialists in the field.

## Conclusion

Based on the present study, one can conclude that medical residents perform an adequate number of colonoscopies during their training, which enables them to achieve ADRs, CIRs, and examination times within the limits proposed by the literature. There is room for improvement as they gain experience, emphasizing the importance of continuous data auditing.

### Conflict of Interests

The authors have no conflict of interests to declare.

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