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Analysis of Patients Undergoing Colonoscopies and the Importance of Exam Quality for Colorectal Cancer Screening

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Summary

Objective To determine the impact of the quality of colonoscopy examination for colorectal cancer screening.

Methods Retrospective observational study of medical records from patients treated at the endoscopy and colonoscopy service of Hospital Universitário Evangélico Mackenzie (Curitiba, PR, Brazil) from January 2019 to January 2020.

Results The analysis was based on 337 medical records from patients with adenomas identified during colonoscopy, and 1,385 medical records from patients without adenomas. The estimated occurrence rate of diagnosis of adenoma during colonoscopy in the target population of the study was of 19.6%, with a 95% confidence interval ranging from 17.7 to 21.5%. Of the 337 patients with adenoma, 136 (40.4%) presented the advanced form. Statistical analysis indicated a significant association between the quality of colonoscopy preparation and test completion.

Conclusion The quality of colonoscopy images is a critical factor for colorectal cancer screening, as it leads to higher rates of adenoma detection and test completion.

Keywords
- adenoma
- colorectal neoplasms
- colonoscopy
- colonic polyps

Introduction

Colorectal cancer (CRC) is the fourth most common type of cancer among adults in the United States. It is the second leading cause of death by cancer in that country, with more than 50,000 deaths each year.[1]

In Brazil, there is an estimate of 20,540 and 20,470 cases of CRC in men and women, respectively, occurring each year of the 2020 to 2022 triennium. These figures correspond to an estimated risk of 19.64 new cases per 100,000 men and 19.03 per 100,000 women. Excluding non-melanoma skin tumors, CRC is the second most frequent neoplasm in men from the Southeast (28.62/100,000) and Midwest (15.40/100,000) Brazilian regions. It is the third most frequent tumor in Southern Brazil (25.11/100,000), according to the 2020 estimate of the Brazilian National Cancer Institute (INCA). Adenoma screening and removal is associated with a lower incidence of cancer. The early detection of adenoma also helps guide counseling regarding periodic surveillance using colonoscopy.[2–4]

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The most important factor in detecting polyps is the examiner's performance, regardless of patient-related factors. The increased number of detected lesions also relies on high-quality colonoscopies, better equipment, and good colon preparation.[2,5,6]

Advanced adenomas are defined as adenomas with more than three lesions, at least one adenoma larger than 10 mm, at least one adenoma with high-grade dysplasia, villous adenoma, or a combination of these characteristics. Advanced adenomas are very relevant due to their association with a higher risk of CRC and development of metachronous lesions. Therefore, post-polypectomy surveillance recommendations warrant a higher frequency of reassessment.[2–4,6–9]

Detection rate improvement requires the following test quality criteria: A) proper colonoscopy time, ensuring a minimum of 30 minutes for each primary diagnostic and screening colonoscopy, and a minimum of 45 minutes for each colonoscopy due to a positive fecal occult blood test. B) Referral evaluation. C) Bowel preparation, which is considered adequate if it allows the detection of polyps >5 mm in size and presents a ≥ 6 score on the Boston scale (with a minimum of 2 points for each segment), or a ≤ 7 score on the Ottawa scale; in addition, at least $\geq 90\%$ of procedures should be properly followed, with a goal of $\geq 95\%$. D) Cecal intubation rates, with the minimum being above 90%, and a goal of 95%; E) Device withdrawal time of at least 6 minutes. F) Adenoma detection rate (ADR) according to the European Society of Gastrointestinal Endoscopy (ESGE) and the American Society for Gastrointestinal Endoscopy (ASGE) guidelines, which recommend an ADR of $\geq$ 25%; the ASGE also suggests a gender-based threshold for ADR of $\geq 30\%$ for men and $\geq 20\%$ for women.; G) Appropriate lesion management (polypectomy technique, polyp recovery, resection site, and tattooing); and H) adequate follow-up intervals. The most important of all recommended measures is ADR.[10]

Adenoma detection rate is the proportion of screening colonoscopies with at least one adenoma found. An ADR lower than 20% is associated with a 10% higher risk of interval cancer when compared to detection rates greater than 20%. Therefore, higher ADRs are directly proportional to better clinical outcomes.[5,10–13]

Known risk factors for CRC include age over 50 years, male gender, smoking, obesity, diabetes, as well as family history, and genetic predisposition to cancer.[14,15]

Most studies recommend starting colonoscopy screening at 50 years old for the medium-risk population. Since it is not uncommon in daily clinical practice to find advanced adenomas or neoplasms in younger people, some guidelines have recommended starting screening at 45 years old, including the updated CRC screening guidelines from the American Cancer Society (ACS).[1,16]

Our main objective was to determine the impact of the quality of the colonoscopy examination for CRC screening. A secondary goal was to describe ADR in our service.

Methods

Study type

A retrospective observational study was conducted to analyze the medical records of patients treated at the endoscopy and colonoscopy service of Hospital Universitário Evangélico Mackenzie (HUEM) in Curitiba, PR, Brazil, from January 2019 to January 2020. The Research Ethics Committee from HUEM approved this research project under the Certificate of Ethical Appreciation Presentation number 36201420.7.0000.0103, opinion number 4.221.329.

Inclusion criteria

A total of 1,722 medical records from patients aged 18 years old and older who underwent colonoscopy from January 2019 to January 2020 were included and evaluated.

Exclusion criteria

Patients under 18 years old, and those whose medical records had insufficient data for analysis were excluded from this study.

Analyzed variables

The patient-related variables collected and analyzed here included gender, age, smoking, comorbidities, as well as personal and family history of CRC. The procedure-related variables were complete colonoscopies, cecal intubation, and colon preparation conditions. We also analyzed the variables related to adenomatous polyp, such as location, size, morphology, and histological patterns. Advanced adenomatous polyps were differentiated.

At our hospital, the method of colon preparation classification is based partially on the Ottawa Scale, according to the following criteria: Good – clearly visible mucosal detail with almost no stool residues, or some cloudy liquid or stool residues with mucosal details still visible with no need for lavage/suction. Regular – some cloudy fluid from stool residues obscuring mucosal details, which become visible with suction, but no lavage required. Poor – stools obscure mucosal details and contours, and visualization is moderate after suction and lavage. Inadequate – solid stools obscure mucosal details, and lavage and suction do not remove them.[17]

As this was a retrospective study, not all medical records had information on certain variables. Thus, sample numbers (n) for each variable represent the number of medical records or polyps with relevant data.

Statistical validation

Quantitative variables were described as mean, standard deviation (SD), and minimum and maximum values. Categorical variables were described as frequency and percentage values. Adenoma occurrence rates estimates were based on 95% confidence intervals (95% CI). The association between two categorical variables was analyzed using the chi-squared test. Values of $p < 0.05$ indicated statistical significance. Data were analyzed using the Statistical Package for the Social Sciences, Standard Edition (StataCorp LLC. College Station, TX, USA) software, version 14.1.

Table 1 Patient-related variables

Variable	Valid n	Classification	Result*
Age (years old)	337		64.2 ± 10.0 (25–88)
Age range (years old)	337	18–50	24 (7.1%)
		Over 50	313 (92.9%)
Gender	337	Female	196 (58.2%)
		Male	141 (41.8%)
Smoking	306	Yes	45 (14.7%)
		No	212 (69.3%)
		Ex	49 (16.0%)
Systemic arterial hypertension	306	No	170 (55.6%)
		Yes	136 (44.4%)
Diabetes mellitus II	304	No	251 (82.6%)
		Yes	53 (17.4%)
Coronary disease	308	No	271 (88.0%)
		Yes	37 (12.0%)
Colorectal neoplasm	308	No	284 (92.2%)
		Yes	24 (7.8%)
Family history**	307	No	260 (84.7%)
		Yes	47 (15.3%)
Colonoscopy preparation	337	Good	162 (48.1%)
		Regular	126 (37.4%)
		Bad	23 (6.8%)
		Inadequate	26 (7.7%)
Test completion	336	Yes	311 (92.6%)
		No	25 (7.4%)
If not, why?	22	Technical difficulty	10 (43.5%)
		Improper preparation	12 (52.2%)
Number of adenomas	337	1	188 (55.8%)
		2	73 (21.7%)
		3	33 (9.8%)
		4	21 (6.2%)
		5 or more	22 (6.5%)
Advanced adenoma***	337	No	201 (59.6%)
		Yes	136 (40.4%)

Notes: *Described as "mean ± standard deviation (minimum–maximum)" or "frequency (percentage)". **A positive family history for colorectal cancer is defined as the presence of a first-degree relative with colorectal cancer before the age of 50 years old or a known history of a genetic syndrome linked to colorectal cancer. ***Defined by the presence of more than three lesions, at least one adenoma larger than 10 mm, at least one adenoma with high-grade dysplasia, villous adenoma, or combinations of these characteristics.

Results

Our analysis was based on 337 medical records from patients with adenomas discovered during colonoscopy, and a control group composed of 1,385 medical records from patients without adenomas. ►**Table 1** shows that most patients were females (58.2%), with a mean age of 64.2 years (25–88 years).

Patients with or without adenomas presented significant differences. For the adenoma group, mean age was 5.5 years higher, and there were 7.1% more male patients, when compared with the control group (►**Table 2**).

The estimated occurrence rate of adenoma detection during colonoscopy in the target population was of 19.6%, with a 95% CI ranging from 17.7 to 21.5%.

Of the 337 patients with adenoma, 136 (40.4%) had advanced adenoma, with a 95% CI ranging from 35.1 to 45.6%.

►**Table 3** presents adenomatous polyps-related factors. Data from up to five polyps were recorded for each patient. Not all polyps detected had all their analyzed characteristics included in the medical record. Thus, *n* reflects the number of polyps with analyzed features.

Dysplasia was classified as low-grade or high-grade. Adenomas with low-grade dysplasia presented mild or moderate dysplastic changes. Both the adenomas with severe dysplasia and those with carcinoma in situ were deemed lesions with high-grade dysplasia.[18]

We tested a null hypothesis of the lack of association between polyp size ($\leq$ 10 mm or $>$ 10 mm), and dysplasia classification against the alternative hypothesis of an actual association (►**Table 4**).

Data on *size* and *dysplasia* were available for 481 polyps: 448 with size $\leq$ 10 mm and 33 with size $>$ 10 mm. Since the remaining polyps had no available data for one or both variables, analysis encompassed all polyps with valid data.

Statistical tests indicated the existence of a significant association between polyp size and dysplasia. ►**Table 4** shows that polyps bigger than 10 mm present a higher percentage of high-grade dysplasia and a lower rate of absent dysplasia.

We also tested the null hypothesis of no association between the quality of colon preparation and test completion versus the alternative hypothesis of an actual association (►**Table 5**).

The statistical test indicated a significant association between the quality of colonoscopy preparation and colonoscopy completion. The data in ►**Table 5** show that poor or inadequate preparation resulted in a higher number of incomplete tests compared to good or regular preparation.

Discussion

According to the literature, CRC is associated with older age. Although ACS recommends CRC screening in average-risk subjects starting at 45 years old, other programs recommend screening in people aged 50 and older.[1,15,19,20] Among the adenoma-related aspects evaluated here, age above 50 years old was an independent risk factor since its association with the disease was significantly different between the two groups.

Table 2 Age and gender variables in patients with or without adenoma

Variable	Classification	Group		*P*-value
		Without adenoma*	With adenoma*	
Age (years old)		58.7 ± 14.1 (11–94)	64.2 ± 10.0 (25–88)	< 0.001
Age range	18 to 50	315 (23.5%)	24 (7.1%)	
	Over 50	1,028 (76.5%)	313 (92.9%)	< 0.001
Gender	Female	906 (65.4%)	196 (58.3%)	
	Male	479 (34.6%)	140 (41.7%)	0.015

Note: *Described as "mean ± standard deviation (minimum – maximum)" or "frequency (percentage)."

Table 3 Adenomatous polyp-related variables

Variable	Valid n	Classification	Result*
Size (mm)	615		5.3 ± 4.9 (1–40)
Location	632	Cecum	49 (7.8%)
		Ascending colon	82 (13%)
		Transverse colon	84 (13.3%)
		Descending colon	73 (11.6%)
		Sigmoid colon	160 (25.3%)
		Rectum	184 (29%)
Morphology	625	Pediculated	78 (12.5%)
		Sessile	547 (87.5%)
Adenoma histological type	521	Tubular	423 (81.2%)
		Serrated	60 (11.5%)
		Tubulovillous	37 (7.1%)
		Villous	1 (0.2%)
Dysplasia classification	516	Low grade	383 (74%)
		High grade	133 (26%)

Note: *Described as "mean ± standard deviation (minimum–maximum)" or "frequency (percentage)."

Table 4 Relationship between polyp size and grade of dysplasia

Dysplasia	Size (mm)	
	≤ 10	> 10
Low grade	344	12
	76.8%	36.4%
High grade	104	21
	23.2%	63.6%
Total	448	33

Note: *P*-value < 0.001; Chi-squared test $p < 0.05$.

Table 5 Relationship between colonoscopy preparation and test completion

Complete test	Colonoscopy preparation			
	Good	Regular	Bad	Inadequate
Yes	152	121	18	20
	94.4%	96.0%	78.3%	76.9%
No	9	5	5	6
	5.6%	4.0%	21.7%	23.1%
Total	161	126	23	26

Note: *P*-value <0.001; Chi-squared test $p < 0.05$.

Several clinical and lifestyle-related risk factors for CRC were described in the literature, including smoking, alcohol intake, high blood pressure, dyslipidemia, diabetes, and obesity.[15] A comparative analysis of some of these factors in patients with adenomas allowed the description of characteristics of this study's population. According to data from the Brazilian Health Department (VIGITEL, 2019), the frequency of diabetes and arterial hypertension is of approximately 7.7% and 24.7%, respectively, in Brazilian subjects of both genders; in addition, the percentage of adult smokers in Curitiba is of 11.4% for both genders. This demonstrates a disparity between arterial hypertension and adenomas in our sample (44.4%) since the remaining risk factors were closer to its occurrence in the general population.[21]

Among the 1,722 colonoscopies evaluated at our institution, ADR was deemed adequate and within the confidence interval, albeit borderline, leading us to consider potential improvements.[5,11–13] We know that high ADRs achieved by endoscopists result in lower rates of interval CRC, as well as lower rates of advancedCRC.[11,13] It is important to highlight that our ADR has limitations, as tests were performed by different examiners at a medical residency service which trains new endoscopists. As such, we must consider that endoscopists with similar individual ADRs may impact the total adenoma detection rate, as there are differences between ADR and the number of adenomas per colonoscopy (APC). While ADR has the best-established goal, it is a "one and done" parameter, as the endoscopist may reach the target ADR and perform a poor-quality test, leading to a

wide range of total rates. Minimum APC targets were proposed but not endorsed by any consensus.[9,12]

Several techniques may improve colonoscopy and increase ADR, including better colon preparation, device withdrawal time greater than 6 minutes, and dynamic changes in positioning. Even so, many lesions go unnoticed. In an attempt to minimize these mistakes, mechanical and optical devices were developed for methodological improvement, leading to better outcomes.[13] In our opinion, these devices should be widely available, economically viable, simple to use, reliable, and highly effective. However, our institution is philanthropical and a regional reference center within the Brazilian Unified Health System, so access to such equipment is challenging, and its impact on clinical practice is debatable.

A proper bowel preparation is essential for optimal visualization of the intestinal mucosa, minimizing the risk of non-detection of lesions.[17] In addition, inadequate bowel preparation is related to lower rates of lesion detection, less satisfactory overall outcomes, increased frequency of post-colonoscopy surveillance, lower rates of cecal intubation, and lengthy procedures that may result in increased costs.[17] Our study showed a significant association between the quality of bowel preparation and test completion. Even though performing high-quality procedures within a public health service can be challenging, it is important to look for methods to improve outcomes. A viable and easy-to-apply option in clinical practice is the use of proprietary instruments, such as well-established and validated scales, to evaluate the quality of bowel preparation.[17] The Boston scale is a validated, reliable, and easily reproducible instrument for assessing bowel preparation.[22] Other aspects that impact the quality of colonoscopy exam include application mode, bowel preparation ingredients, and educational techniques. Educating patients is essential, but excessively technical information can make understanding difficult, especially for subjects with lower educational levels.[22] Therefore, booklets with simple information about bowel preparation guidelines are valuable and can improve test quality.

It is well established in the literature that advanced polyps change the prognosis and increase the chance of CRC development.[23] Although small polyps are the most frequent, in these cases lesions with advanced histological features are uncommon.[24] Despite advances in technology and the high quality of endoscopic studies, we must emphasize that failure to recognize an adenoma in small polyps and, consequently, the use of the resect and discard strategy could lead to an erroneous low-risk classification and inappropriate patient follow-up.[25] It is important to note that small polyps present a non-negligible risk of histological progression. Our research demonstrated that the polyp's size influences the chance of histological progression, although we could not attribute a clinical meaning to this finding.

Conclusion

The quality of colonoscopy examination is a critical factor for CRC screening, as it leads to higher rates of adenoma detection and test completion.

Authors contributions

Marcos Venícios Furlanetto: Project design, literature review, data organization, article writing and submission.
Jaqueline Alves Zwierzikowski: Project design, literature review, data collection and organization, article writing and submission.
Carolina Fischer Bertoldo: Project design, literature review, data collection and organization, article writing and submission.
Guilherme Andretta Sotto Maior Wistuba: Project design, literature review, data collection and organization, article writing and submission.
Eduardo Issao Brand Tashima: Project design, literature review, data organization, article writing and submission.
Ana Helena Bessa Gonçalves Vieira: Project supervision, roles delegation and supervision, review of the article writing and submission process.
Henrique Luckow Invitti: Project guidance, roles delegation and supervision, review of the article writing and submission process.
Antonio Sérgio Brenner: Project guidance, roles delegation and supervision, review of the article writing and submission process.

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Conflict of Interests

The authors have no conflict of interests to declare.

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