



Performance of Computer-Aided Detection and Quality of Bowel Preparation: A Comprehensive Analysis of Colonoscopy Outcomes

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Abstract

Background Artificial intelligence (AI) has emerged as a promising tool for detecting and characterizing colorectal polyps during colonoscopy, offering potential enhancements in traditional colonoscopy procedures to improve outcomes in patients with inadequate bowel preparation.

Aims This study aimed to assess the impact of an AI tool on computer-aided detection (CAdE) assistance during colonoscopy in this population.

Methods This case–control study utilized propensity score matching (PSM) for age, sex, race, and colonoscopy indication to analyze a database of patients who underwent colonoscopy at a single tertiary referral center between 2017 and 2023. Patients were excluded if the procedure was incomplete or aborted owing to poor preparation. The patients were categorized based on the use of AI during colonoscopy. Data on patient demographics and colonoscopy performance metrics were collected. Univariate and multivariate logistic regression models were used to compare the groups.

Results After PSM patients with adequately prepped colonoscopies ($n = 1466$), the likelihood of detecting hyperplastic polyps (OR = 2.0, 95%CI 1.7–2.5, $p < 0.001$), adenomas (OR = 1.47, 95%CI 1.19–1.81, $p < 0.001$), and sessile serrated polyps (OR = 1.90, 95%CI 1.20–3.03, $p = 0.007$) significantly increased with the inclusion of CAdE. In inadequately prepped patients ($n = 160$), CAdE exhibited a more pronounced impact on the polyp detection rate (OR = 4.34, 95%CI 1.6–6.16, $p = 0.049$) and adenomas (OR = 2.9, 95%CI 2.20–8.57, $p < 0.001$), with a marginal increase in withdrawal and procedure times.

Conclusion This study highlights the significant improvement in detecting diminutive polyps (< 5 mm) and sessile polyps using CAdE, although notably, this benefit was only seen in patients with adequate bowel preparation. In conclusion, the integration of AI in colonoscopy, driven by artificial intelligence, promises to significantly enhance lesion detection and diagnosis, revolutionize the procedure's effectiveness, and improve patient outcomes.

Keywords Colonoscopy · Artificial intelligence · Computer-aided detection · Colon preparation

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Introduction

The field of gastrointestinal (GI) endoscopy has seen a surge in interest and research regarding the application of computer-aided detection and diagnosis (CAdE/CADx) in colonoscopy [1]. This technology has shown promise in various aspects of colonoscopy, particularly in detecting and diagnosing colonic polyps and adenocarcinoma [1]. Inadequate bowel preparation can lead to missed pathologic lesions, procedural cancelations, increased costs, and delays in diagnosis [2]. The use of CAdE in colonoscopy can impact colonoscopy performance metrics, especially in the setting of inadequate bowel preparation. Therefore, it is essential

to comprehensively analyze the outcomes of colonoscopy, particularly the impact of CADe on the adequacy of bowel preparation. Artificial intelligence (AI), particularly CADe and CADx, is gaining importance in GI endoscopy and is under regulatory review, reflecting its potential in clinical practice [3]. Clinical studies show CADe enhances adenoma detection rates (ADR) and adenomas per colonoscopy (APC) regardless of size. CADx systems have been shown to offer real-time polyp histology diagnoses during colonoscopy, underlining their transformative role in the field [4].

In colonoscopy, the quality of bowel preparation has been identified as a crucial factor affecting the efficiency and outcomes of the procedure [5]. Per the multi-society position statement on Quality Indicators for Colonoscopy, the target achievement of Adequate Bowel Prep should be at least 85%. Factors such as age, medical history, runway time < 5 h between split-dose preparations, and patient compliance have been found to influence the adequacy of bowel preparation, emphasizing the multifaceted nature of this aspect of colonoscopy [6–8]. Given the complexity and importance of adequate bowel preparation in colonoscopy, conducting a comprehensive analysis of colonoscopy outcomes is imperative. Thus, we aimed to evaluate the impact of CADe on performance metrics for adequate and inadequate bowel preparations.

Material and Methods

This case–control study used a propensity score matching approach to evaluate the impact of CADe on colonoscopy outcomes. The study population included patients who underwent colonoscopy at our institution between January 1, 2017 and December 31, 2023. A total of 4497 colonoscopies were initially considered for analysis. Institutional Review Board (IRB) approval was obtained from the University of Alabama at Birmingham IRB (IRB-300011665). Patient data privacy adhered to IRB guidelines. The present study complied with the STROBE guidelines for observational studies [9].

Study Population

The study involved patients aged 45–75 years who underwent colonoscopy with or without CADe. This study utilized data from a registry at our institution. Conventional high-definition endoscopes were used during all procedures. A real-time CADe system was added to the endoscopic equipment during colonoscopy procedures (GI GENIUS Intelligent Endoscopy Module (Medtronic, MN, USA). This CADe system can highlight the regions with visual characteristics consistent with different types of mucosal abnormalities, aiding the operation in enhancing polyp detection.

Interventions, such as polypectomies, were performed according to the standard of care.

Exclusion criteria comprised patients with incomplete medical records, missing colon preparation adequacy, aborted procedures before reaching the cecum due to reasons other than inadequate bowel preparation (e.g., patient discomfort or cardiopulmonary instability), colonoscopies that were aborted before reaching the cecum due to poor bowel cleanliness were excluded, and non-visualized segments were assigned a Boston Bowel Preparation Scale (BBPS) segment score of zero [10].

To minimize confounding factors, propensity score matching was performed separately for adequately and inadequately prepared colonoscopies. Propensity scores were calculated using a logistic regression model with variables, including age, sex, race, and indication for colonoscopy (diagnostic or surveillance).

Assessment of Colonoscopy Preparation Adequacy

The adequacy of colonoscopy preparation was evaluated using the BBPS, scoring cleanliness in the right, transverse, and left colon segments on a 0–3 scale. Adequate preparation required a minimum of 2 per segment for clear mucosal visibility, with an overall score above six indicating sufficiency [10]. A sub-analysis of participants with sub-optimal preparation (BBPS < 6) assessed the impact on diagnostic efficacy and patient care, highlighting the importance of bowel preparation in colorectal exam outcomes.

Outcomes

This study captured a comprehensive set of variables and measurements encompassing demographic information, colonoscopy findings, and performance metrics. Demographic variables included the age and sex of the patients. The colonoscopy findings were detailed, including polyp type (adenomas, hyperplastic polyps (HPs), and sessile serrated polyps (SSP/Ls)), number and size of polyps, and specific anatomic locations within the colon. The performance metrics comprised crucial indicators, such as the ADR, SSP/L detection rate (SSLDR), and colorectal cancer (CRC) detection rate. Definitions were established for critical parameters, including classifications based on polyp size and number (e.g., < 1 cm or > 1 cm for SSP/Ls and 1–2, 3–10, > 10 for tubular adenomas (TAs)).

Statistical Analysis

A rigorous data depuration process identified and addressed anomalies or outliers. Statistical analyses validated the data, and cross-referencing carefully examined and confirmed outliers. Data quality was assessed through

random audits of a sample (5%) of the medical records to ensure consistency and accuracy. Documentation of the data management process was maintained for transparency.

Data are presented as frequencies and percentages for categorical variables and as means (SD) and medians (IQR) for continuous variables. Crude odds ratios were calculated using appropriate tests. A multivariate conditional logistic regression model adjusted for potential confounders (age, sex, and withdrawal time) was also constructed. All analyses were conducted using Stata

Statistical Software Release 18 (StataCorp LLC, College Station, TX, USA).

Results

This study included 4497 colonoscopies initially considered. After excluding 46 procedures because of incomplete data, 4451 colonoscopies remained eligible for further categorization (Fig. 1). Among the eligible colonoscopies, 3978

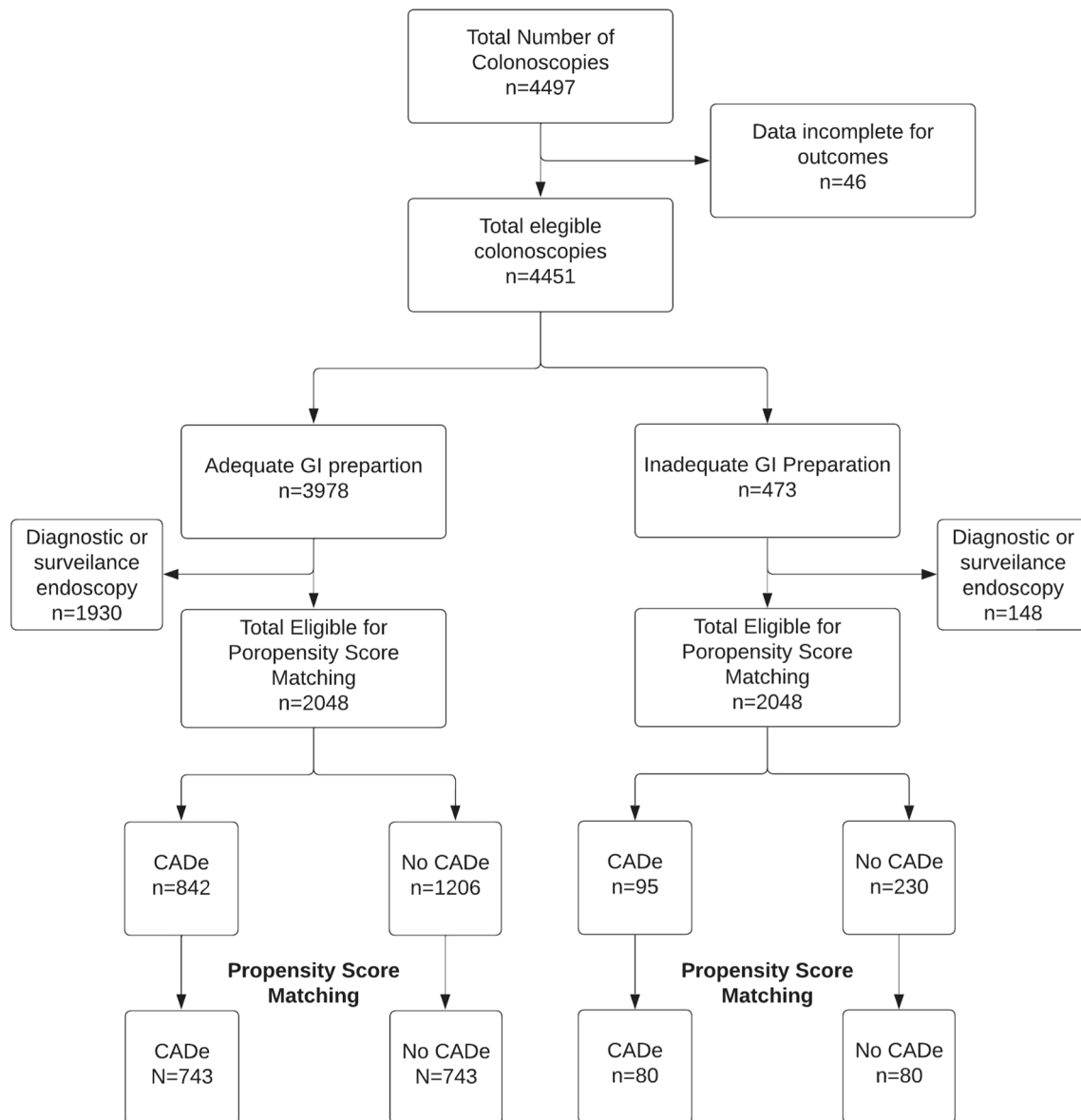


Fig. 1 Flowchart of colonoscopy types categorized by preparation adequacy and computer-aided detection (CAdE) use. Legend: This figure shows a flowchart summarizing the categorization of colonoscopy procedures from a dataset. It starts with the total number of colonoscopies, narrows down to those that are eligible, and then splits them into two categories: adequately prepped colonoscopies

and inadequately prepped colonoscopies. Each category was further divided based on whether CAdE was used. Once the groups were selected, propensity score matching was independently performed for both groups. The numbers beside each category indicate the number of procedures in that subset

(89.4%) had adequate GI preparation, while 473 (10.6%) had inadequate preparation. In cases with adequate preparation, 1930 patients were identified for either diagnostic or surveillance endoscopy. Within this subgroup, 2048 procedures were assessed for suitability for propensity score matching based on whether CADe was utilized. In the CADe group, 842 procedures were performed, compared to 1206 procedures without CADe. Following propensity score matching, 733 pairs were successfully matched for analysis.

One hundred and forty-eight procedures were categorized as diagnostic or surveillance endoscopies for inadequately prepared colonoscopies. Similarly, these were assessed for propensity score matching with a total of 2048 procedures. Among these, 95 procedures used CADe, whereas 230 did not. Post-propensity score matching resulted in 80 matched pairs for the comparative analysis.

The results from the propensity score matching indicated a balanced comparison between the CADe and non-CADe groups across adequately and inadequately prepared

colonoscopies. This matching allows for a more accurate assessment of the impact of CADe on colonoscopy outcomes under various bowel preparation conditions.

Adequately Prepped Colonoscopies

Among adequately prepared colonoscopies, using CADe yielded higher rates of polyps, number of polyps retrieved, hyperplastic polyps, adenomas, and sessile polyps (see Supplement Table 1). We analyzed only individuals with an average risk screening colonoscopy to further elucidate these findings, yielding similar findings (see Supplement Table 2). However, in these two models, age, sex, and race were found to be significantly different. To account for these differences, propensity score matching for age, sex, and race, adequately prepped colonoscopies with and without CADe revealed significant findings across various parameters (Table 1).

The mean withdrawal time was significantly higher in the CADe group (13.4 min, SD 6.5) than in the no CADe

Table 1 Table of general characteristics of propensity score-matched patients with adequately prepped average risk colonoscopies ($n = 1466$)

	No CADe $N = 733$	CADe $N = 733$	Total $N = 1466$	p value
Age	54.7 (8.0)	54.7 (8.0)	54.7 (8.0)	1
Gender				1
Female	454 (61.9%)	454 (61.9%)	908 (61.9%)	
Male	279 (38.1%)	279 (38.1%)	558 (38.1%)	
Race				1
White	342 (46.7%)	342 (46.7%)	684 (46.7%)	
Black	326 (44.5%)	326 (44.5%)	652 (44.5%)	
Other	65 (8.9%)	65 (8.9%)	130 (8.9%)	
Withdrawal time (min), mean (SD)	10.72 (7.17)	13.36 (6.48)	12.04 (6.96)	<0.001
Total procedure duration (min), mean (SD)	18.08 (8.92)	19.23 (7.79)	18.66 (8.39)	0.009
Yield of colonoscopy				
Any Polyp	362 (49.4%)	489 (66.7%)	851 (58.0%)	<0.001
Polyp size (mm), mean (SD)	4.4 (3.1)	3.9 (2.31)	4.2 (2.7)	0.006
Number of polyps retrieved	1.0 (1.6)	1.6 (1.9)	1.3 (1.8)	<0.001
Diminutive polyps (<5 mm)	282 (78.8%)	413 (84.6%)	695 (82.2%)	0.028
Hyperplastic polyps	87 (24.0%)	141 (29.0%)	228 (26.9%)	0.11
Adenoma present	254 (34.7%)	321 (43.8%)	575 (39.2%)	<0.001
Number of TA's				
1–2 TAs	178 (49.2%)	216 (44.4%)	394 (46.4%)	0.16
3–10 TAs	50 (13.8%)	85 (17.5%)	135 (15.9%)	0.15
> 10 TAs	0 (0.0%)	2 (0.4%)	2 (0.2%)	0.22
Advanced neoplasm	60 (8.2%)	51 (7.0%)	111 (7.6%)	0.37
Adenocarcinoma	0 (0.0%)	1 (0.1%)	1 (0.1%)	0.32
Sessile polyp present	28 (7.7%)	67 (13.8%)	95 (11.2%)	0.006
SSP < 1 CM	24 (6.6%)	55 (11.3%)	79 (9.3%)	0.021
SSP > 1 CM	9 (2.5%)	20 (4.1%)	29 (3.4%)	0.2

CADe Computer-aided detection; TA tubular adenoma; p values were calculated using t test for continuous variables and chi-square test for categorical variables; N number of patients; SD standard deviation. The values in parentheses represent the range or percentage where applicable. Significance level set at $p < 0.05$

Table 2 Table of general characteristics of propensity score-matched patients with inadequately prepped average risk colonoscopies ($n = 160$)

	No CADe $N = 80$	CADe $N = 80$	Total $N = 160$	p value
Age	60.4 (9.0)	60.4 (9.0)	60.4 (9.0)	1
Gender				1
Female	40 (50.0%)	40 (50.0%)	80 (50.0%)	
Male	40 (50.0%)	40 (50.0%)	80 (50.0%)	
Race				1
White	34 (42.5%)	34 (42.5%)	68 (42.5%)	
Black	44 (55.0%)	44 (55.0%)	88 (55.0%)	
Other	2 (2.5%)	2 (2.5%)	4 (2.5%)	
Withdrawal time (min), mean (SD)	5.2 (5.8)	11.7 (9.6)	8.4 (8.6)	<0.001
Total procedure duration (min), mean (SD)	11.9 (8.5)	18.6 (11.1)	15.3 (10.4)	<0.001
Yield of colonoscopy				
Any Polyp	33 (41.2%)	49 (61.3%)	82 (51.2%)	0.011
Polyp Size (mm), mean (SD)	4.3 (3.7)	3.8 (2.2)	4.0 (2.9)	0.4
Number of polyps Retrieved	0.6 (1.5)	1.2 (1.5)	0.9 (1.5)	0.005
Diminutive polyps (< 5 mm)	26 (81%)	40 (83%)	66 (82%)	0.81
Hyperplastic polyps	5 (21%)	10 (20%)	15 (21%)	0.97
Adenoma present	13 (16.2%)	32 (40.0%)	45 (28.1%)	<0.001
Number of TAs				
1–2 TAs	9(38%)	22 (45%)	31 (42%)	0.55
3–10 TAs	3 (12%)	10 (20%)	13 (18%)	0.41
> 10 TAs	1 (4%)	0 (0%)	1 (1%)	0.15
Advanced neoplasm	1 (1.2%)	3 (3.8%)	4 (2.5%)	0.31
Adenocarcinoma	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Sessile polyp present	1 (4%)	7 (14%)	8 (11%)	0.19
SSP < 1 CM	0 (0%)	7 (14%)	7 (10%)	0.051
SSP > 1 CM	1 (4%)	1 (2%)	2 (3%)	0.6

CADe Computer-aided detection; TA tubular adenoma; p values were calculated using t test for continuous variables and chi-square test for categorical variables; N number of patients; SD standard deviation. The values in parentheses represent the range or percentage where applicable. Significance level set at $p < 0.05$

group (10.7 min, SD 7.1) ($p < 0.001$) (Mean Difference: 2.7 SE – 0.35 min). Similarly, the total procedure duration was significantly longer in the CADe group (19.2 min, SD 7.8) compared to the no CADe group (18.73 min, SD 9.11) ($p = 0.013$) with a mean difference of $1.14 \pm SE 0.43$ min.

Using CADe in colonoscopies significantly improved polyp detection rates, with 66.7% of polyps detected in the CADe group compared with 49.4% in the non-CADe group ($p < 0.001$). The average number of polyps retrieved was also higher with CADe assistance (1.6 per procedure versus 1.0 in the non-CADe group ($p < 0.001$)). Furthermore, CADe was particularly effective in identifying smaller polyps, as evidenced by a mean polyp size of 3.9 mm in the CADe group compared to 4.4 mm in the non-CADe group ($p = 0.006$) and an increased detection rate of diminutive polyps (< 5 mm) at 84.6% with CADe versus 78.8% without ($p = 0.028$).

The yield of colonoscopy findings varied significantly between the two groups. CADe was associated with a higher adenoma detection rate [ADR] (43.8 vs. 34.7%, $p < 0.001$).

The presence of sessile polyps was significantly higher in the CADe group (13.8 vs. 7.7%, $p = 0.006$), particularly for polyps < 1 cm (11.3 vs. 6.6%, $p = 0.021$). There were no differences in the yield of HPs, advanced adenomas, adenocarcinomas, and SSP/L > 1 cm.

Inadequately Prepped Colonoscopies

In colonoscopies with inadequate preparation, use of CADe was associated with significantly higher polyp detection rates, increased polyps retrieved, and greater identification of HPs, adenomas, and SSP/Ls (see Supplemental Table 3). To assess the robustness of these findings, we conducted a sub-analysis of individuals undergoing average risk screening colonoscopies, which confirmed the initial observations (see Supplemental Table 4).

In our analysis of 160 propensity score-matched patients undergoing inadequately prepared average risk colonoscopies, no significant differences were observed in the general

Table 3 Adjusted odds ratios in propensity-scored matched individuals for colonoscopy quality indicators using and not using CAdE

	Adequate Prep				Inadequate Prep			
	aOR	95% CI	<i>p</i> value		aOR	95% CI	<i>p</i> value	
<i>Adequate prep</i>								
Any polyp	2.05	1.66	2.54	<0.001	2.25	1.20	4.24	0.012
Number of polyps Retrieved	2.01	1.63	2.48	<0.001	4.34	2.20	8.57	<0.001
Diminutive polyps (<5 mm)	1.48	1.04	2.11	0.028	1.15	0.36	3.71	0.81
Hyperplastic polyps	1.29	0.94	1.76	0.110	0.97	0.29	3.25	0.966
Adenoma present	1.47	1.19	1.81	<0.001	3.44	1.63	7.23	0.001
Number of TA's								
1–2 TAs	0.82	0.63	1.08	0.164	1.36	0.50	3.69	0.549
3–10 TAs	1.32	0.90	1.93	0.152	1.79	0.44	7.24	0.411
Advanced neoplasm	0.84	0.57	1.24	0.375	3.08	0.31	30.24	0.335
Sessile polyp present	1.90	1.20	3.03	0.007	3.83	0.44	33.11	0.222
SSP < 1 CM	1.79	1.09	2.96	0.022	Omitted			
SSP > 1 CM	1.68	0.76	3.73	0.203	0.48	0.03	8.01	0.609

CAdE Computer-aided diagnosis; TA tubular adenoma; aOR adjusted odds ratios. Odds ratios calculated conditional logistic regression model adjusted for age, gender, and race

characteristics between the CAdE and no CAdE groups. Both groups maintained an identical distribution in terms of age (60.4 years, SD=9.0), sex (50% female, 50% male), and race (55% Black, 42.5% White, 2.5% Other) ($p=1.0$).

Significant differences were observed in the procedure duration metrics. The CAdE group exhibited longer withdrawal times (11.7 vs. 5.2 min, $p<0.001$) and total procedure durations (18.6 vs. 11.9 min, $p<0.001$) compared to the no CAdE group. This extended time was associated with enhanced polyp detection; the CAdE group achieved a higher overall polyp detection rate (61.3 vs. 41.2%, $p=0.011$) and retrieved more polyps per procedure (1.2 vs. 0.6, $p=0.005$).

While there was no significant difference in average polyp size between the groups, the incidence of adenomas was substantially higher in the CAdE group (40.0 vs. 16.2%, $p<0.001$). The detection rates of diminutive polyps, hyperplastic polyps, and advanced neoplasms were not significantly different. Sessile polyps were more frequently detected in the CAdE group, particularly small sessile polyps (SSP < 1 cm), which were found at a rate of 14% compared to none in the no CAdE group, which was statistically significant ($p=0.051$) (Table 2).

Association of CAdE with Colonoscopy Quality Indicators

In this propensity score-matched analysis, we evaluated the effectiveness of CAdE on colonoscopy quality indicators and compared the outcomes between adequately and inadequately prepped colonoscopies. The results demonstrated that CAdE significantly enhanced the detection of various polyp types across different bowel preparation levels (Table 3).

For adequately prepared colonoscopies, the use of CAdE significantly increased the odds of detecting any polyp (adjusted odds ratio [aOR]=2.05, 95% CI 1.66–2.54, $p<0.001$) and retrieval of a greater number of polyps (aOR=2.01, 95% CI 1.63–2.48, $p<0.001$). Furthermore, there was a significant improvement in the detection of diminutive polyps of <5 mm (aOR=1.48, 95% CI 1.04–2.11, $p=0.028$) and adenomas (aOR=1.47, 95% CI 1.19–1.81, $p<0.001$). Sessile polyps were also detected more frequently with CAdE, especially small sessile polyps less than 1 cm (aOR=1.79, 95% CI 1.09–2.96, $p=0.022$).

In colonoscopies with inadequate preparation, the odds of detecting any polyp were significantly higher (aOR=2.25, 95% CI 1.20–4.24, $p=0.012$), as were the number of polyps retrieved (aOR=4.34, 95% CI 2.20–8.57, $p<0.001$). The detection of adenomas was substantially increased (aOR=3.44, 95% CI 1.63–7.23, $p=0.001$). While increases were observed in the odds of detecting advanced neoplasms (aOR=3.08, 95% CI 0.31–30.24, $p=0.335$) and sessile polyps (aOR=3.83, 95% CI 0.44–33.11, $p=0.222$), these were not statistically significant.

Discussion

This study aimed to comprehensively analyze colonoscopy outcomes, explicitly focusing on the impact of CAdE on performance metrics in the context of adequate and *Inadequate* bowel preparation. The findings of our study, conducted at a single tertiary referral center, shed light on the nuanced relationships between CAdE, patient characteristics, and colonoscopy outcomes.

Our investigation revealed that using CADe significantly influenced various aspects of colonoscopy procedures, particularly those prepared adequately. Those procedures employing CADe exhibited higher odds of finding polyps, smaller polyps (particularly diminutive polyps < 5 mm), adenomas, and tubular adenomas in patients with a lower number of TA (< 10 TAs) and SSP/Ls, especially those < 1 cm, suggesting a potential association between CADe usage and specific colonoscopy characteristics. Similarly, inadequately prepared colonoscopies with CADe demonstrated higher detection rates for the same colonoscopy quality metrics than those without CADe (polyp detection rate, number of polyps per colonoscopy, adenoma detection rate, and small sessile polyps). Procedural withdrawal times (WT) and total durations were slightly longer in those with CADe than in those without CADe in adequately prep patients (WT 1.9 min and total time 0.7 min longer) and in *Inadequately* prepped patients (WT 4.0 min and total time 3.8 min longer). These findings highlight the need for a nuanced understanding of the impact of CADe on colonoscopy outcomes, considering the variations in patient preparation.

The integration of CADe in colonoscopy has garnered significant attention because of its potential to enhance the detection and diagnosis of colonic polyps and adenomas [11]. Recent advancements in artificial intelligence, particularly with deep learning in computer vision, have facilitated the development of CADe systems, enabling real-time histologic classification of colon polyps. CADe assistance offers an extra pair of eyes in the field of view. It is, therefore, a promising solution to address human variation in performance during colonoscopy, providing decision support and potentially improving the detection rates of colonic lesions [12].

Adequate bowel preparation is crucial. With a BBPS score of 2 or 3, the miss rate for adenomas > 5 mm is 5%. This rate jumps to 16% with a score of 1 [13]. Most “missed” CRCs after a “normal” screening occurs within 3.5 years, particularly sessile lesions in the right colon, highlighting the risk of inadequate preparation [14]. From a GIQuic Database, only 32% of inadequate preps were told to return for < 12 months. Utilizing CADe helps to ensure the maximal benefit for an inadequately prepped colonoscopy. Moreover, the quality of the recording for bowel preparation can be subjective and inaccurate. CADe assistance can prove valuable in these settings, as demonstrated in our study. Additionally, newer CADe software updates have the potential to assess bowel cleanliness during the procedure, helping to standardize interpretations of BBPS and reduce subjectivity in colonoscopy outcomes.

These findings align with previous research that has demonstrated the potential of CADe in improving colonoscopy effectiveness by increasing adenoma detection rates and reducing adenoma miss rate [15, 16] to the effect that the

World Endoscopy Organization (WHO) has acknowledged the potential benefits of CADe in improving colonoscopy effectiveness and increasing adenoma detection rates, while also highlighting the challenges in its implementation [11, 17].

Previous research highlights CADe’s potential to improve adenoma detection and reduce miss rates, thereby transforming colonoscopy outcomes and reducing interval cancer rates [11]. Automated polyp detection, a key component of CADe, has been associated with lower rates of interval cancers, further underscoring the potential of CADe in enhancing the effectiveness of colonoscopy [4]. Although CADe shows promise in improving colonoscopy effectiveness, further study is still required. Its accuracy surpasses that of non-experts, suggesting that it can augment the capabilities of endoscopists and pathologists [15].

The impact of CADe on colonoscopy quality indicators has been investigated, revealing associations with patient age, withdrawal time, and detection rates of hyperplastic polyps, adenomas, and sessile polyps [4, 11, 16–18]. The use of CADe has been linked to longer withdrawal times and higher odds of detecting hyperplastic polyps and adenomas, particularly in inadequately prepped patients, highlighting its potential to reduce the impact of *Inadequate* bowel preparation on lesion detection but underscoring the importance of bringing the patients back earlier for surveillance. Evidence suggests that CADe is remarkably effective in aiding the detection of SSP/Lss [12]. In particular, diminutive polyps are more challenging to diagnose, and CADe has been found to improve the detection rate of these lesions [19]. This is consistent with the growing body of evidence supporting the potential of CADe in enhancing colonoscopy outcomes and addressing the challenges associated with human biases and performance [20–22]. CADe has been assumed to be beneficial for improving colonoscopy quality in trainees and decreasing the adenoma miss rate [23].

Our findings emphasize the importance of adhering to guidelines for managing patients with inadequate bowel preparation and highlighting the role of timely re-evaluation, especially with AI technology in endoscopy-enhancing lesion detection. These guidelines advocate for earlier follow-up endoscopies in cases of inadequate preparation and point to better patient education and tools to improve preparation scores. If colonoscopy reaches the cecum but preparation is inadequate, a repeat examination within a year with a more intensive regimen is advised, mainly if advanced neoplasia is detected, requiring shorter follow-up intervals [24]. Our study demonstrates that using CADe in inadequately prepped colonoscopies improves adenoma detection, which can help reduce the burden at repeat colonoscopy and potentially further reduce the risk of interval colorectal cancer as it optimizes the quality of the inadequately prepared colonoscopy.

Limitations

Several limitations of this study should be considered when interpreting its results. First, the retrospective nature of our study design introduced inherent biases and limitations. The reliance on data from a single tertiary referral center may limit the generalizability of our findings. Furthermore, the potential for selection bias must be noticed as the study population was drawn from a specific institution's registry. To mitigate potential selection bias, we employed a propensity score matching approach, adjusting for variables, such as age, sex, race, and indication for colonoscopy, thereby enhancing the comparability between groups. Another limitation pertains to the variability in reporting practices in the BBPS, and potential subjectivity in scoring may have affected the accuracy of our classification of adequately and inadequately prepared colonoscopies. Furthermore, we excluded patients with incomplete medical records or missing data on colon preparation adequacy to address the potential for subjectivity in the scoring of bowel preparation.

Conclusion

In conclusion, the integration of CAde with colonoscopy represents a significant advancement in the field of gastrointestinal endoscopy with the potential to improve the detection and diagnosis of colonic lesions. AI, particularly deep learning techniques, has paved the way for the development of CAde systems that offer decision support, enhance endoscopists' capabilities, and aid in decision-making on surveillance by detecting lesions even with inadequate bowel preparation. Although the implementation of CAde in clinical practice is still evolving, evidence suggests that it holds promise for revolutionizing the effectiveness of colonoscopy and improving patient outcomes.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s10620-024-08610-7>.

Author's contributions Dalton Norwood contributed to data analysis, study design, manuscript composition, manuscript review, and editing. Tatiana Torres contributed to data capture, manuscript review, and editing. Amanda Cartee contributed to manuscript composition, review, and editing. Kirk Russ contributed to manuscript composition, manuscript review, and editing. Patricia Ajayi-Fox contributed to manuscript composition, manuscript review, and editing. Anam Hameed contributed to manuscript composition, manuscript review, and editing. Ramzi Mulki contributed to manuscript composition, review, and editing. Eleazar E. Montalvan-Sanchez contributed to manuscript composition, review, and editing. Faye Sarkis contributed to manuscript composition, review, and editing. Sergio A Sánchez-Luna contributed to manuscript composition, review, and editing. Shyam Thakkar contributed to study design, manuscript composition, review, and editing. Douglas R Morgan contributed to Study design, manuscript composition, manuscript review, and editing. Shajan Peter contributed to data

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Data availability No datasets were generated or analyzed during the current study.

Declarations

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