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Mohammed Ahsan
NCH Healthcare System 311 9th St. N. Suite 300 Naples, FL 34102-5804 Academic Office: 239-624-0940, mohammedahsan313@gmail.com

Zackary Anderson
NCH Healthcare System 311 9th St. N. Suite 300 Naples, FL 34102-5804 Academic Office: 239-624-0940

Medjine Jarbath
NCH Healthcare System 311 9th St. N. Suite 300 Naples, FL 34102-5804 Academic Office: 239-624-0940

Maged Bakr
NCH Healthcare System 1285 Creekside Blvd E, Ste 102, Naples, 34109, FL,

Raymond W. Phillips
Gastroenterology Group of Naples 1064 Goodlette-Frank Rd N, Naples, FL 34102

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The Impact of Computer-aided Detection Technology in Adenoma Detection Rate Among Experienced Endoscopists in the Community Setting

Mohammed Ahsan [a,*], Zackary Anderson [a], Medjine Jarbath [a], Maged Bakr [b], Raymond W. Phillips [c]

[a] NCH Healthcare System, 311 9th St. N. Suite 300, Naples, FL 34102-5804, USA
[b] NCH Healthcare System, 1285 Creekside Blvd E, Ste 102, Naples, FL 34109, USA
[c] Gastroenterology Group of Naples, 1064 Goodlette-Frank Rd N, Naples, FL 34102, USA

Abstract

Adenoma detection rate (ADR) is a key quality metric in screening colonoscopies. An adenoma detection rate of greater than 30% reduces the incidence of colorectal carcinoma (CRC). Furthermore, studies have demonstrated an inverse relationship between ADR and the incidence of CRC. Computer aided detection (CAD) can improve ADR, but these studies have largely been in major medical centers. In this retrospective single center observational study, screening colonoscopies in average-risk patients were compared among 5 experienced endoscopists in the year before and the year after implementation of the CAD (GI Genius). Training for GI Genius was completed in December 2021 and the technology was implemented the beginning of January 2022. We evaluated the adenoma detection rate (ADR) for 1838 screening colonoscopies in 2021 (before CAD incorporation) and 2629 screening colonoscopies in 2022 (after CAD incorporation) to assess efficacy of AI-assisted colonoscopy. Our study demonstrates that the incorporation of CAD technology in a group of experienced endoscopists in a community setting significantly improved ADR. The ADR of the entire group increased significantly ($p < 0.05$) following the implementation of CAD technology. The improvement in ADR was attributed to an increased detection of small (<6 mm) polyps. The clinical significance of improved detection of small polyps is uncertain, and further investigation should be done on the economical benefit of incorporating an AI model in the community setting.

Keywords: Colorectal cancer, Endoscopy, Artificial intelligence, Gastroenterology, Adenoma detection rate

1. Introduction

Screening colonoscopy prevents colon cancer by detecting and removing adenomatous polyps which reduces the risk of the progression to colorectal cancer.[1] A key quality metric of a screening colonoscopy is the adenoma detection rate (ADR), which is inversely related to the incidence of colorectal cancer (CRC) after a screening colonoscopy.[2] An ADR of greater than 30% significantly reduces the incidence of post screening colonoscopy CRC.[3] Some studies have found variability in ADR (ranging from 13 to 53% in certain cases) which has been attributed to experience, fatigue, and case complexity.[4,5]

Computer aided detection (CAD) during a colonoscopy has emerged as an option to improve the adenoma detection rate. Multiple studies in major medical centers have demonstrated statistically significant increases in ADR when compared to unaided colonoscopy.[6] One multicenter randomized control trial showed that CAD technology led to increased ADR in screening colonoscopies regardless of endoscopist experience.[7] This study also showed that AI-assisted colonoscopies led to statistically increased detection of number of adenomas per colonoscopy as well. Furthermore, polyps located in the cecum, ascending colon, and rectum have traditionally been more difficult to

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* Corresponding Author.
E-mail address: mohammedahsan313@gmail.com (M. Ahsan), Zackary.Anderson@nchmd.org (Z. Anderson), Medjine.Jarbath@nchmd.org (M. Jarbath), Maged.Bakr@nchmd.org (M. Bakr), raymondwphillipsmd@gmail.com (R.W. Phillips).

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detect. This observation is underscored by the higher incidence of CRC in these locations following a screening colonoscopy.[8] CAD colonoscopies could potentially overcome this limitation, since CAD improves ADR in not only the distal colon but in the proximal colon.[7]

ADR may decline as the operator fatigues over the course of the day. In a retrospective study in Australia, while both morning and afternoon colonoscopies demonstrated ADR greater than the minimum benchmark of 30%, afternoon colonoscopies had a statistically significant decrease in ADR by 6% compared to the morning.[9] With the incorporation of CAD technology into colonoscopies at an academic setting, it was found that AI was able to mitigate the effects of operator fatigue by maintaining a consistent ADR throughout the day, compared to the control group.[10]

Most CAD studies have been completed in large referral centers or academic institutions. What is not clear is if CAD technology can be used as a viable tool to improve ADR in community hospital outpatient setting. Our study aims to explore this issue further, by evaluating the ADR in the year before and the year after the incorporation of CAD (GI GENIUS) in a suburban community outpatient setting. Additionally, this study examined the effects of CAD on ADR as it relates to polyp size, location, and operator fatigue.

2. Materials & methods

A single-center retrospective study was performed at Naples Community Hospital (NCH) Endoscopy Center, Naples, Florida. This center serves an outpatient population. The information was obtained from digital records maintained at NCH through PROVATION and EPIC. There are many CAD systems, but the technology used in our facility was the GI GENIUS. Briefly, the GI GENIUS works to provide physicians with live alerts by scanning the visual frames being processed through the colonoscopy camera. It then analyzes the various shapes, shadows, and lines using the AI software and highlights the region of interest with a green box for the physician. The physician then makes the ultimate decision on whether to remove the polyp or not based on their expertise.

Data from five experienced gastroenterologists was collected for the years of 2021 and 2022 for comparison. Experience was defined as greater than 5 years of clinical practice beyond fellowship training. The CAD technology (GI GENIUS) was implemented in the first week of January 2022 and was utilized for every procedure. Each endoscopist was aware that the CAD technology system was activated, with removal of polyps based upon user discretion. Polyps were then analyzed by GI pathologists at NCH. Only screening colonoscopies for average risk patients were recorded for each endoscopists from 2021 to 2022. If there was any significant family history of colon cancer, those patients were excluded from the study.

The primary outcome studied was the ADR for each endoscopists in the calendar year 2021 and the calendar year 2022. CAD (GI Genius) was implemented in the first week of January 2022. The following data was collected for each examination including number of polyps, polyp size, polyp location, procedure time, and total procedure duration. Polyp size was categorized by either being small (0–5 mm), medium (6–10 mm), or large (greater than 10 mm). Polyp location, was categorized as "cecum, ascending colon, hepatic flexure, transverse colon, descending colon, sigmoid colon, and rectum." As a surrogate marker of operator fatigue, the time of day (morning versus afternoon) the procedure was recorded as well as the number of adenomas detected during that period. The total duration of each procedure was also recorded in minutes for the morning and afternoon procedures.

In terms of statistical analysis, a Chi–Square test was performed comparing the ADR between 2021 and 2022 to assess the primary outcome. For secondary outcomes, several Chi-square tests were performed to assess the distribution of polyp size before and after CAD incorporation, and polyp location with ADR from 2021 to 2022. Finally, a Chi-square test was utilized to assess for operator fatigue by comparing the ADR of the morning and afternoon colonoscopies for each year. The average procedure duration for each year (2021 vs 2022) by time of day (morning vs afternoon) was compared via an unpaired T-test. A p-value less than or equal to 0.05 was considered the benchmark for statistical significance.

3. Results

Screening colonoscopies by five endoscopists were examined from 2021 to 2022. The primary outcome investigated the ADR before and after the incorporation of the CAD technology in January 2022. In 2021, a total of 1838 screening colonoscopies were completed and a total of 2629 screening colonoscopies were completed in 2022. Between 2021 and 2022, while 4 of the 5 endoscopists had an increase in ADR after the incorporation of the CAD technology, there was no statistical difference found individually. When comparing the average ADR for all endoscopist a statistically significant difference was detected between 2021 and 2022. The average ADR in 2021 for all endoscopists was 47%, but improved to 52% with the incorporation of the GI genius model in 2022 (Fig. 1).

Among the various secondary outcomes examined was the difference in polyp size between 2021 and 2022. Polyp size was broken down into the following categories: small (0–5 mm), medium (6–10 mm), or large (greater than 10 mm). Among all 5 experienced endoscopists studied, a statistically significant difference was found in small polyp size between 2021 and 2022. In contrast, no statistically significant difference was found among polyps of medium or large size (Table 1). Individually, there was a statistically significant difference noted for small polyps among endoscopist A and E, for medium polyps among endoscopist C and E, and large polyps only among endoscopist E.

In comparing data from 2021 to 2022 the difference in ADR at different locations within the colon between all endoscopists was not significantly different. When the ADR by location for each endoscopists was evaluated, there were statistically significant differences in ADR among two of the endoscopists at the hepatic flexure (endoscopist B and endoscopist D) and rectum for endoscopist A. Interestingly, the ADR was reduced in these

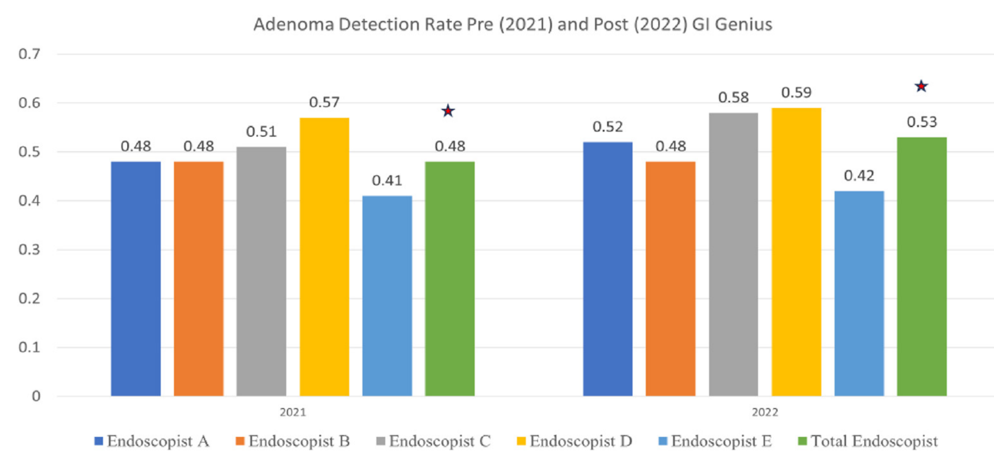

Fig. 1. The ADR was compared among 5 endoscopist between 2021 and 2022 - when the CAD technology was implemented. Individually, there was no statistically significant difference in ADR among endoscopists. On the contrary, when investigating the group data among endoscopists between 2021 and 2022, there was a statistically significant difference with a P value of 0.017.

Table 1. Cumulative and proportionate data of adenomas by polyp size.

	Small Polyps	Medium Polyps	Large Polyps
Endoscopist A	338 (0.65)*	164 (0.31)	22 (0.04)
	334 (0.58)*	208 (0.36)	36 (0.06)
Endoscopist B	241 (0.84)	31 (0.11)	13 (0.05)
	421 (0.88)	39 (0.08)	18 (0.04)
Endoscopist C	114 (0.77)	25 (0.17)*	7 (0.05)
	268 (0.70)	98 (0.26)*	15 (0.04)
Endoscopist D	233 (0.83)	38 (0.14)	9 (0.03)
	374 (0.86)	51 (0.12)	9 (0.02)
Endoscopist E	372 (0.61) *	180 (0.29)*	60 (0.10)*
	546 (0.71)*	175 (0.23)*	47 (0.06)*
Net Endoscopist	1298 (0.70)*	438 (0.24)	111 (0.06)
	1937 (0.74)*	571 (0.22)	125 (0.05)

Table 1: White boxes represent 2021 data while dark shade boxes represent 2022 data (with incorporation of GI GENIUS). *Statistical significance at P value of < 0.05

locations. Only one endoscopist (E) improved in location specific ADR (the cecum and sigmoid colon) following implementation of CAD (Table 2).

Finally, when evaluating the effect of operator fatigue on ADR, a statistically significant difference was not found when comparing the ADR for the morning and afternoon procedures for each endoscopists in 2021 and 2022. Upon reviewing individual data for the endoscopists, three (A, D, E) had a trend of decreased ADR in the afternoon compared to the mornings in both years. However, only one endoscopist (endoscopist D) was found to have a statistically significant difference in the reduction of ADR in the afternoon compared to the morning in 2022 when the CAD technology was active (Table 3).

Another secondary outcome studied to assess operator fatigue was total procedure time. The comparison should be between the morning vs afternoon in 2021. The hypothesis is that fatigue will affect the duration of a procedure. In 2022 with AI the hypothesis is that any fatigue related effect on duration of procedure will be eliminated by use of

Table 2. Cumulative adenomas with ADR by location per endoscopist.

	Cecum	Ascending Colon	Transverse Colon	Descending Colon	Sigmoid Colon	Rectum	Hepatic Flexure	Total Screening Colonoscopies
Endoscopist A	44 (.08)	115 (.22)	118 (.23)	71 (.14)	103 (.20)	67* (.13)	5 (.01)	523
	54 (.09)	150 (.26)	134 (.23)	83 (.14)	96 (.17)	48* (.08)	13 (.02)	578
Endoscopist B	38 (.13)	68 (.24)	82 (.29)	37 (.13)	27 (.09)	29 (.10)	4* (.01)	285
	61 (.13)	115 (.24)	123 (.26)	59 (.12)	56 (.12)	63 (.13)	1* (.002)	478
Endoscopist C	23 (.15)	36 (.24)	21 (.14)	29 (.19)	21 (.14)	16 (.11)	3 (.02)	149
	42 (.11)	67 (.17)	70 (.18)	81 (.21)	47 (.12)	66 (.17)	6 (.01)	379
Endoscopist D	35 (.12)	46 (.16)	113 (.40)	40 (.14)	24 (.09)	17 (.06)	6* (.02)	281
	54 (.12)	89 (.20)	155 (.36)	62 (.14)	58 (.13)	17 (.04)	1* (.002)	436
Endoscopist E	68* (.11)	88 (.15)	96 (.16)	81 (.14)	76* (.13)	190 (.32)	1 (.002)	600
	53* (.07)	89 (.12)	141 (.19)	88 (.12)	127* (.17)	259 (.34)	1 (.001)	758
Net Endoscopist	208 (.11)	353 (.19)	430 (.23)	258 (.14)	251 (.14)	319 (.17)	19 (.01)	1838
	264 (.10)	510 (.19)	623 (.24)	373 (.14)	384 (.15)	453 (.17)	22 (.01)	2629

Dark shade boxes are 2021 data. White shade is 2022 data. Data includes the cumulative numbers, along with ADR in parentheses .
*Statistical significance at P value of <.05, Chi -square test

Table 3. Comparison of ADR by morning and afternoon for 2021 and 2022 by endoscopist.

	Endoscopist A	Endoscopist B	Endoscopist C	Endoscopist D	Endoscopist E	All Endoscopist
2021	0.50	0.48	0.43	0.57	0.43	0.48
	0.46	0.49	0.56	0.56	0.38	0.47
2022	0.54	0.47	0.59	0.66*	0.49	0.54
	0.5	0.5	0.57	0.47*	0.47	0.50

Dark shade boxes morning data (before noon). White shade is afternoon data (after 12 noon) * Statistical significance at P va lue of <.05.

Table 4. Average procedure duration per endoscopist in the morning and afternoon for 2021 and 2022.

	Endoscopist A	Endoscopist B	Endoscopist C	Endoscopist D	Endoscopist E	All Endoscopist
2021	17.32 min	17.41 min	20.01 min	14.94 min	14.88 min	16.51 min
	16.92 min	17.76 min	18.23 min	13.95 min	13.83 min	16.01 min
2022	14.11 min	18.16 min	18.16 min	14.62 min*	14.27 min	15.54 min
	13.54 min	17.59 min	18.43 min	12.98 min*	14.38 min	15.41 min

Dark shade boxes morning data (before noon) . White shade is afternoon data (after 12 noon) * Statistical significance at P v alue of <.05.

AI. The comparison should be between the morning vs afternoon in 2022. When looking at the data amongst individual physicians, endoscopist A was noted to have a statistically significant decrease in procedure time in both the morning and afternoon from 2021 to 2022 (Table 4).

4. Discussion

In this retrospective community-based study of CAD (GI Genius) among a group of experienced endoscopists, we found a statistically significant increase in ADR from 48 to 53% in the year following the utilization of CAD. This study found that the increase in ADR was largely due to the increased detection of smaller polyps (<6 mm). This finding is consistent with reported study on AI-assisted colonoscopy.[11,12]

To the question of whether CAD can enhance ADR in each colonic segment, we examined ADR in relation to location with the colon. There was only one endoscopist who showed a significant improvement in ADR in a particular segment within the colon. Curiously, three endoscopists had reduced ADR within various locations of the colon (cecum, rectum, and hepatic flexure) following the implementation of CAD. This data suggests that AI technology may not lead to improved detection of polyps within difficult locations of the colon. When considering that the AI technology utilizes the colonoscopy camera to process and detect polyps, future innovations focusing on optimizing image quality may lead to better detection of polyps in difficult locations.

Another area this study investigated was the impact of AI technology in mitigating operator fatigue. Interestingly, there was no statistically significant reduction in ADR between 2021 and 2022 when comparing morning to afternoon cases. There was an insignificant decrease in ADR in the afternoon in 2021, which persisted in 2022 when the CAD model was implemented. This suggests that CAD was not able to overcome or mitigate the impact of operator fatigue. Endoscopists should be mindful of the effect of fatigue on the effective performance of screening colonoscopy and should consider limiting the time allocated to procedures on a particular day.

There are a number of limitations to this study. It is retrospective. It is not randomized. An additional limitation of this study was that some screening studies were deferred during 2020 due to the COVID pandemic. This is the explanation for the reduced numbers of screening examinations in 2021 vs 2022. Furthermore, given that the CAD system was in its first year in 2022, there was likely a learning curve in terms of comfort level that may have impacted the way endoscopists interacted with the AI technology. For instance, this may have influenced endoscopists to remove polyps that they typically would not since they were being prompted by the AI system, leading to increased resections of smaller polyps.

The features of this study that make it relevant is that it represents the implementation of AI technology among a group of experienced endoscopists/gastroenterologists. This point is underscored by the high baseline ADR of each endoscopists compared to the benchmark goal of greater than 30%, prior to even the use of the CAD model in 2022. Interestingly, the baseline ADR of endoscopists in our study was also considerably higher than that of expert endoscopists in the multicenter study done in referral centers; their pre-CAD ADR was around 32.8% compared to 48% in our group.[7] After the incorporation of the CAD model, the ADR among expert endoscopists rose to 42.3% in the multicenter study, while it increased to 53% in our group.[7] Thus, while the CAD model led to a higher ADR among our community endoscopists, there was a larger improvement of approximately 10% in the larger referral center study, suggesting that a low baseline ADR may impact the efficacy of the CAD model. Moreover, our study is a suburban community setting which is where the overwhelming majority of screening colonoscopes are performed in the United States.

The increased ADR that was observed following implementation of CAD suggests a clinical benefit to this technology. The risk for advanced colorectal cancer with small polyps is minimal, as the most high-risk adenomas are typically greater than 10 mm.[13] However, in our study this increased ADR could be wholly attributed to an increase in the number of small (<6 mm) adenomatous polyps identified and removed.

Thus, this raises the question of how clinically relevant the 5% increase in ADR is in this patient population. When considering the immediate technology costs and the cost of increased numbers of colonoscopies in the future due to reduced surveillance intervals, future studies should analyze the economic impact of incorporating a CAD model in practice. Finally, given that the CAD model appears to have a net positive impact in ADR, perhaps the greatest benefit for implementation of this technology would be among endoscopists with a lower baseline ADR rate.

In summary, this study demonstrated that in a community hospital setting CAD significantly increases ADR in screening colonoscopies though increased detection of small (<6 mm) polyps. This increased detection of diminutive polyps may have minimal clinical impact but will certainly increase health care costs.

Ethics information

All patient identifying information where removed from this paper in accordance with HIPPA compliance, and consent was obtained prior to publication.

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Disclaimers

3 abstracts derived from this manuscript have been accepted for presentation at Digestive Disease Week 2024 at Washington DC and AFMR Southeastern Regional Meeting 2024 at Birmingham, Alabama.

Author guarantor

Mohammed Ahsan accepts full responsibility for the conduct of this study.

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Conflict of interest

No financial or conflicts of interest to disclose for any researchers in the study.

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