REVIEW

Clin Endosc 2025;58:514-517
https://doi.org/10.5946/ce.2024.338
pISSN: 2234-2400 • eISSN: 2234-2443

Open Access

CLINICAL ENDOSCOPY

Computer-aided diagnosis of colorectal polyps: assisted or autonomous?

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Computer-aided diagnosis (CADx) in colonoscopy aims to improve the accuracy of diagnosing small polyps; however, its integration into clinical practice remains challenging. Human-artificial intelligence (AI) collaboration, which is expected to enhance optical diagnosis, has shown limited success in clinical trials, with studies indicating no significant improvement in human-only performance. Conversely, autonomous CADx systems that operate independently of clinicians have demonstrated superior diagnostic accuracy in some studies, suggesting their potential for efficiency, consistency, and standardization in healthcare. However, the adoption of autonomous AI raises ethical, legal, and practical concerns such as accountability for errors, loss of clinical context, and clinician or patient distrust. The decision between using CADx as an assistant or as an autonomous system may depend on the clinical scenario. Autonomous systems can standardize routine screening for low-risk patients, whereas assistive systems may complement expertise in complex cases. Regardless of the model used, robust regulatory frameworks and clinician training are essential to ensure safety and maintain trust. Balancing the strengths of AI with the critical role of human judgment is the key to optimizing outcomes and navigating the complex implications of integrating CADx technologies into colonoscopy practice.

Keywords: Adenoma; Artificial intelligence; Colonoscopy

INTRODUCTION

Encountering small or diminutive polyps (≤5 mm) is a common practice in colonoscopy. The management of these polyps often involves a quick decision-making process, with cold polypectomy following an optical diagnosis, either classifying the polyp as neoplastic (requiring removal) or non-neoplastic (which may not require removal). However, the accuracy of optical diagnosis in real-world settings is often disappointing, with significant variability among different operators.[1] To address this challenge, the use of artificial intelligence (AI) technology in the form of computer-aided diagnosis (CADx) has attracted attention, as it promises to improve the quality of optical diagnosis independent of the operator's expertise.

However, despite its potential, integrating CADx into routine practice remains challenging. Recent prospective studies reported unexpected results (Table 1).[2-6] Four large-scale observational studies found no substantial improvement in diagnostic accuracy when AI was used in collaboration with human endoscopists compared with human-alone performance.[2-5] Moreover, a randomized trial indicated that autonomous AI (without human assistance) outperformed AI-human collaboration in terms of diagnostic accuracy.[6] These findings present a difficult issue: how should CADx be implemented in clinical practice? This issue is complicated by the role of human-AI interaction,

Received: December 23, 2024 **Revised:** January 8, 2025
Accepted: January 11, 2025

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Table 1. Overview of four prospective studies comparing human alone vs. AI-assisted diagnosis and a randomized trial comparing AI alone (autonomous AI) vs. AI-assisted diagnosis

Study	Design	Sensitivity for adenomas (%)			Specificity for adenomas (%)		
		Human alone	AI-assisted	AI alone	Human alone	AI-assisted	AI alone
Barua et al.[2]	Prospective trial	88.4	90.4	-	83.1	85.9	-
Rondonotti et al.[3]	Prospective trial	88.6	88.6	81.9	88.8	88.1	88.7
Hassan et al.[4]	Prospective trial	85.0	85.1	81.8	98.0	97.0	94.9
Rex et al.[5]	Prospective trial	90.7	90.8	-	59.5	64.7	-
Djinbachian et al.[6]	Randomized trial	-	83.6	84.8	-	63.8	64.4

AI, artificial intelligence; -, no data is available.

which lies at the intersection of behavioral science and technology, a field with which many endoscopists are unfamiliar.

This review assesses the current status of CADx during colonoscopy and discusses its prospects. The main takeaway from the available evidence is that while human-AI collaboration does not significantly improve optical diagnosis, autonomous AI may provide greater diagnostic accuracy than the combination of humans and AI. This raises an important question: should we use CADx as an assistant or as an autonomous system? We will explore this question from clinical, ethical, and legal perspectives.

CADx AS AN ASSISTANT

In this model, CADx tools are designed to support the endoscopist's decision-making process. Typically, endoscopists first make their own optical diagnoses and then refer to CADx suggestions for the final decision-making process. Preclinical studies have shown that CADx alone can outperform human-only diagnosis in optical detection, suggesting that human-AI collaboration might improve performance.[7] However, this has not yet been confirmed in clinical trials. Four rigorously designed prospective trials demonstrated no significant improvement in diagnostic accuracy when CADx was used in conjunction with human judgment.[2-5] Why is this the case?

We hypothesized that endoscopists may underutilize CADx suggestions by placing more weight on their own clinical judgment. Cognitive overload can occur when clinicians simultaneously process CADx recommendations and their own assessments. This may lead to decision fatigue or confusion, particularly when the AI's conclusions contradict the clinician's intuition.[8] Additionally, a lack of trust in CADx systems may contribute to the underuse of their recommendations.[8] If a CADx system consistently misidentifies certain polyp types, clinicians may unconsciously adopt these errors into their diagnostic approaches.

While CADx as an assistant could have potential benefits, such as human oversight and a possible learning effect over time, the current data do not support its widespread use during colonoscopy procedures, primarily because of the few additional clinical benefits.

CADx AS AN AUTONOMOUS SYSTEM

Autonomous CADx systems go a step further by removing clinicians from the diagnostic loops. These systems independently analyze polyp characteristics, make diagnostic decisions, and recommend management strategies such as resection or surveillance. Many endoscopists believe that autonomous AI is too futuristic or legally unacceptable. However, there are already examples of autonomous AI systems in other areas of medicine, such as AI-based tools for diagnosing diabetic retinopathy[9] and abnormalities in chest X-rays,[10] which do not require a physician's involvement in decision-making. Although autonomous AI tools are not yet available in the field of gastroenterology, this possibility should be considered in future studies.

What are the advantages of autonomous AI for the optical diagnosis of colorectal polyps? The data suggest that autonomous AI performs better than human-AI collaboration. For instance, a Canadian randomized trial found that the accuracy of autonomous AI was superior to that of human-AI collaboration (77% vs. 72%, respectively).[6] Autonomous AI offers several advantages over human-assisted systems. (1) Stability: Autonomous AI systems are hardly influenced by operator fatigue, emotions, or varying expertise, which contributes to greater diagnostic consistency. This stability can help establish reliable healthcare quality. (2) Standardization: Autonomous AI has the potential to provide uniform diagnostic quality regardless of the endos-

copist's skill level, thereby promoting equity in healthcare. This aligns with global health initiatives such as those of the World Health Organization, which focus on equal access to high-quality healthcare. (3) Efficiency: Autonomous systems can reduce the procedure time by eliminating the need for human decision-making, which can improve patient care both clinically and economically.

However, the implementation of fully autonomous CADx systems presents several ethical, legal, and practical challenges. (1) Accountability: In an autonomous system, determining the liability for diagnostic errors is complex. Who is responsible if the system misdiagnoses a lesion—the clinician, hospital, regulatory body, or system manufacturer? This issue is particularly challenging in endoscopy, where physician involvement is essential. It is difficult to eliminate the responsibility of clinicians when they are present during the procedure. A company that manufactures an autonomous AI tool for diabetic retinopathy has prepared insurance for malpractice caused by the AI tool in consideration of the company's liability; however, the liability situation is not that simple in endoscopy practice owing to the presence of endoscopists at the moment of using the autonomous AI as a decision maker.[11] (2) Loss of clinical context: Autonomous systems rely on algorithms and training data, which may fail to account for patient-specific factors that are invisible to these machines, such as patient demographic information, including age, medical history, or comorbidities. This can lead to suboptimal decision-making. (3) Acceptance and trust: Trust in autonomous systems remains a significant barrier. Clinicians may be hesitant to relinquish the control of a machine, and patients may feel uncomfortable receiving diagnoses without human involvement.

CONCLUSIONS

As highlighted, the decision to use CADx as an assistant or autonomous system is not straightforward. This may not be a binary issue, and there could be situations in which both roles are utilized flexibly depending on clinical needs. For instance, during colonoscopy screening in asymptomatic patients with a low risk of advanced polyps, an autonomous CADx system with limited functionality, such as distinguishing between neoplastic and non-neoplastic polyps, may enhance efficiency and standardization, while reducing the risk of misdiagnosing serious lesions. However, in more complex cases involving high-risk patients requiring nuanced decision-making, an assistive CADx system with advanced capabilities, such as cancer differentiation, may complement the clinician's expertise.

Regardless of the chosen model, robust regulatory frameworks are necessary to ensure that CADx systems meet stringent safety, efficacy, and ethical standards. Regular audits, transparency in algorithmic processes, and clinician training are critical for maintaining trust and accountability. The legal responsibility for errors when using autonomous AI in colonoscopy has not been clearly established, which presents a significant challenge for its integration into clinical practice.

Although autonomous CADx systems hold significant promise, their integration must be approached cautiously to balance technological capabilities with the irreplaceable value of human judgment. As evidence continues to evolve, the ultimate goal should remain the same: to leverage CADx technologies to improve patient outcomes through collaboration or autonomy.

Conflicts of Interest

Yuichi Mori has the following conflicts of interest: Olympus Corp (consultation, lecture fees, and device loan) and Cybernet Corp. (loyalty fee). Cesare Hassan has the following conflict interests: Fujifilm Co. (consultancy), Medtronic Co. (consultancy), Odin Vision (consultancy).

Funding

Yuichi Mori receives following funding which is relevant to the present paper: European Commission (Horizon Europe: 101057099) and Japan Society for the Promotion of Science (No. 22H03357). Cesare Hassan receives following funding which is relevant to the present paper, European Commission (Horizon Europe: 101057099), the Associazione Italiana per la Ricerca sul Cancro (AIRC), IG 2022–ID. 27843 project/(AIRC) IG 2023–ID. 29220 project, and Bando PNRR-MCNT2-2023-12377041.

Author Contributions

Conceptualization: all authors; Data curation: all authors; Formal analysis: all authors; Investigation: all authors; Methodology: all authors; Project administration: all authors; Resources: all authors; Supervision: all authors; Validation: all authors; Visualization: all authors; Writing–original draft: all authors; Writing–review & editing: all authors.

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