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The Effect of Artificial Intelligence in Aiding Colonoscopy: A Review of Recent Randomized Control Trial

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Abstract
Colonoscopy, the gold standard for detecting preneoplastic lesions, provides the possibility of resection and prevents lesions from progressing to colorectal cancer. Even when the lesions are within the visual field, they may be missed due to human cognitive limitations. Computer-aided detection (CADe) systems, based on deep learning, could improve the Adenoma detection rate (ADR) by displaying visual alerts that identify precancerous polyps on the endoscopy monitor in real time. We did this literature review by compiling data from PubMed and Google Scholar. In this review, we focused exclusively on randomized control trial studies that had free access. To narrow our search, we applied a filter to include studies published between 2019 to 2024. AI has shown a significant promise in the detection of potentially overlooked adenomas, sessile polyps, and flat, diminutive polyps with increased Adenoma Detection Rate and Polyp Detection Rate. Although AI has its advantages, varying degrees of endoscopist experience and different AI algorithms should be considered. Irrespective of these limitations, AI would be an aid to coloscopy.

Keywords: *Artificial Intelligence, Colonoscopy, Adenoma Detection Rate, Polyp Detection Rate, Sessile polyp, Flat polyp, diminutive polyp.*

1. Introduction

Colorectal cancer ranks third in terms of incidence, but second in terms of mortality (Sung H et al., 2020).Colonoscopy, the gold standard for detecting preneoplastic lesions, provides the possibility of resection and preventing lesions from progressing to Colorectal cancer (Núñez Rodríguez et al., 2020). The effect of screening colonoscopy on colorectal cancer prevention is strongly related to the detection of cancer and premalignant polyps and adenomas Areia M et al., 2022).

Endoscopic characterization of diminutive (1–5 mm) polyp histology during real-time colonoscopy, so-called optical diagnosis, remains the most attractive intervention for an immediate cost saving in screening colonoscopy. With accurate optical diagnosis, diminutive lesions can be resected and discarded without pathological assessment, or left in place without resection in cases of diminutive non-neoplastic polyps located in the distal colon (Houwen et al., 2023). Even when the lesions are within the visual field, they may be missed due to human cognitive limitations. For example, polyps in the visual field may be missed due to being inconspicuous, only briefly visible, or appearing at the edge of the screen. computer-aided detection (CADe) systems, based on deep learning, could improve the ADR by displaying visual alerts that identify precancerous polyps on the endoscopy monitor in real time (Yao L et al., 2022).

The use of computer-aided detection (CADe) and characterization (CADx) systems promise both augmented performance by increased ADR and higher efficiency by firm identification of non-adenomatous polyps. Thus, for example, hyperplastic polyps in the rectosigmoid can be left unresected (Hann, A et al., 2021). In recent years, the usefulness of artificial intelligence (AI) has been reported in solving complex multinomial problems in various fields, including computer-aided detection (CADe) in medicine (Miyaguchi K et al., 2024). In the last 5 years, there have been programs by various companies which allow real-time, computer-aid detection (CADe) of polyps during colonoscopy. However, at the time of writing, there have yet to be any evidence on the improvement AI-aided colonoscopy has on individual endoscopist (Koh FH et al., 2023).

This literature review will dwell about the potential of artificial intelligence aiding in diagnostic and therapeutic field of colonoscopy.

2. Methodology

We did this literature review by compiling data from PubMed and Google Scholar. In this review we exclusively included studies that had free access. To narrow our search, we put a filter for year of publication as 2019 to 2024. Studies that are clinical trial and randomized clinical trials are included. Meta analysis, literature review, systematic review, book and documents, observational studies are excluded. The pool was searched using key words that are, artificial intelligence, screening colonoscopy and colorectal neoplasia.

3. Discussion

In gastroenterology, deep learning systems have recently shown tremendous potential to improve endoscopic performance, and recent studies have reported effective use of AI for computer-aided polyp detection (CADe), classification of polyp histology (CADx), and differentiation of endoscopically resectable polyps (superficial) versus invasive cancer (Wadhwa V et al., 2020).

Machine learning is an artificial intelligence technique in which computers use data to improve their performance in a task without explicit instruction. Examples of machine learning include an application that learns to identify and discard spam emails or a thermostat that learns household temperature preferences over time. Machine learning is often classified into two categories - supervised and unsupervised learning. In supervised learning, a machine is trained with data that contain pairs of inputs and outputs. The machine learns a function to map the inputs to outputs, which can then be applied toward new examples. Linear and logistic regression, which are often employed in clinical research, are examples of supervised machine learning because they produce a regression function that correlates inputs to outputs based on observed data. In unsupervised learning, machines are given data inputs that are not explicitly paired to labels or outputs. The machine is tasked with finding its own structure and patterns from the set of objects. An example of unsupervised learning is clustering, in which a system creates clusters of similar data points from a large data set.

Feature learning refers to a set of techniques within machine learning that asks machines to automatically identify features within raw data as opposed to the features being explicitly labeled. This technique enables machines to learn features and infer functions between inputs and outputs without being provided the features in advance. A subset of feature learning is deep learning, which harnesses neural networks modeled after the biological nervous system of animals. (Alagappan M et al., 2018)

This literature review encompasses 10 randomized control trails, that provides a valuable insight into the efficacy and implication of AI- assisted colonoscopy in various clinical settings.

4. Adenoma Detection Rate (ADR) and Polyp Detection Rate (PDR)

Most studies were centered around the influence of computer aided detection (CADe) in Adenoma detection rate (ADR) and polyp detection rate (ADR). Gimeno-García et al.study suggests that there is an increase in ADR in detecting in CADe group with 55.1% (102/185) compared to 48.8% (81/185) in control group ($p = 0.029$) (Gimeno-García AZ et al., 2023). Similarly, another study found that by Repici et al. AI assistance colonoscopy has higher ADR (54.8% vs 40.4%) (Repici A et al., 2020). Luo et al. detected that there is significantly higher ADR in AI assistance group (38.7% vs 34.0%, $p < 0.001$). This demonstrates that AI assistance can enhance the detection of clinically relevant lesions (Luo Y et al., 2021).

Nevertheless, there are studies that prove otherwise. Ahmad et al. detected that a borderline significance in PDR (85.7% vs 79/7%, $p = 0.05$) (Ahmad A et al., 2023) and another study by Schöler et al.with no significance in ADR (71.4% vs 65.0%, $p = 0.09$) (Schöler J et al., 2024). These mixed results call attention on complexity of implementing AI in clinical practice.

4.1. Detection of Specific Lesion Type

An intriguing feature of CADe lies in its potential of detecting specific types of lesions that are often obscure. Schöler et al. found an improved detection rate of sessile serrated lesion (SSL) with AI assistance (22% vs. 11%, p = 0.004) (Schöler J et al., 2024). Xu et al. conducted a study that detected more diminutive polyp (76/0 vs. 68.8%, p < 0.05) and flat polyp (5.9% vs. 3.3%, p < 0.05) (Xu L et al., 2021). These findings are crucial, as flat and diminutive lesions are often overlooked during conventional colonoscopy yet harbor malignant potential.

4.2. Adenoma Miss Rate (AMR)

A study conducted by Wallace et al. established evidence on CADe's influence on AMR. They found a significant lower AMR in AI study group (15.5% vs 32.4%, adjusted OR, 0.38; 95% CI, 0.23-0.62) (Wallace MB et al., 2022). This reduction in missed adenoma rate is noteworthy, as it addresses one of the primary drawbacks of conventional colonoscopy in screening and surveillance.

4.3. Optical Diagnosis and Decision Support

Djinbachian et al. explored the frontier of AI in colonoscopy by comparing autonomous AI with AI- assisted human (AI-H) diagnosis. While they found no significant difference in accuracy for optical diagnosis in autonomous AI and AI-H group (77.2% with 95% confidence interval, 69.7–84.7 vs. 72.1% with 95% CI, 65.5–78.6,P = .86), autonomous AI showed higher agreement with pathology- based surveillance interval AI-H (91.5% [95% CI, 86.9–96.1] vs 82.1% [95% CI, 76.5–87.7]; P = .016) (Djinbachian R et al., 2024). This study points to the potential of AI not only in lesion detection but also in real time decision- making during colonoscopy procedure.

4.4. Special Population

The study by Hüneburg et al. on Lynch syndrome patients accentuates the potential benefits of AI in the high-risk population. Although the increment in overall adenoma detection of AI-assisted group vs. control group was not statistically significant (26.1% [95% CI 14.3–41.1] vs. 36.0% [22.9–50.8]; p = 0.379) (26.1% [95% CI 14.3–41.1] vs. 36.0% [22.9–50.8]; p = 0.379), the trend towards increased detection of flat adenoma (17/30 [56.6%] vs. 4/20 [20%]; p = 0.018) is noteworthy, given the elevated cancer risk in this population (Hüneburg R et al., 2023).

4.5. Adenomas Per Colonoscopy (APC) and True Histology Rate (THR)

Shaukat et al. [20] established a significant increase in APC with CADe use (1.05 vs 0.83, p = 0.002) without decreasing the THR (Shaukat A et al., 2022). This finding is particularly predominant as it suggests that CADe can improve detection rates without increasing the number of unnecessary polypectomies, thus maintaining procedure efficiency and patient safety.

4.6. Implication and Future Direction

The collective evidence from these studies suggests that CADe has the potential to significantly enhance the quality of colonoscopy procedures. The improvements in detection rates, particularly for challenging lesions like flat adenomas and SSLs, could translate into better prevention and early detection of colorectal cancer. However, the variability in results across studies underscores the need for standardization in AI algorithms and implementation protocols.

5. Limitations

It's paramount to note that most of these studies were orchestrated in controlled settings with varying degrees of endoscopist experience and different AI algorithms. The generalizability of these results to real clinical practice needs further investigation. Additionally, the potential for bias in studies funded by AI technology developers should be considered when interpreting results.

6. Conclusion

The integration of Computer-Aided Detection (CADe) and AI assistance in colonoscopy shows favorable results, particularly in augmented Adenoma Detection Rate (ADR), diminishing Adenoma Miss Rate (AMR), and improving the detection of tricky lesions such as sessile serrated lesions (SSLs) and flat adenomas. Studies established significant upswing in detection rates with CADe, suggesting its capacity to enhance the quality of colorectal cancer screening and prevention. Nevertheless, the mixed results from some studies, including those showing no improvement in Adenoma detection rates, emphasize the complexities of AI implementation in clinical practice. Factors such as capriciousness in AI algorithms, endoscopist experience, and study conditions contribute to these discrepancies.

While the potential of AI in colonoscopy is noticeable, furthermore standardization and validation are essential to ensure reliable performance across diverse clinical settings. Additionally, future research should address possible biases and assess the long-term effect of AI-assisted colonoscopy on patient's outcomes, including cancer prevention and survival rates. Nevertheless, CADe presents as worthwhile tool in modern colonoscopy, with the capacity to enhance lesion detection and decision-making, ultimately improving patient care and safety.

7. Declarations

Ethics Approval and Consent to Participate

Not applicable to a review article.

Consent for Publication

All authors gave their consent for publications.

Availability of Data and Materials

Not applicable as no novel data were generated for this review article.

Competing Interests

No authors have any conflict of interest or competing interests to declare.

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Author Contribution

LSV, PR, JDS researched the data. FAS, SPK, GP, RR wrote the first draft of the manuscript. GP, LSV, SPK, RR(8) edited the manuscript. RR (1)has contributed to conceptualization and supervision, editing of the final manuscript. All authors reviewed and approved the final version of the manuscript.

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