

Next-Gen Screening Review: The Rise of Capsule Colonoscopy in Colorectal Cancer Screening

Akash Patel MD^{1*}, Utsav Vaghani MD², Sarang Tusharbhai Mehta MD³

¹Department of Internal Medicine, Eisenhower Medical Centre, Rancho Mirage, California, USA

²Department of Internal Medicine, UNM Children Hospital, Surat, Gujarat, India

³Department of Internal Medicine, Smt. N.H.L. Municipal Medical College, Ahmedabad, Gujarat, India

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***Corresponding author:** Akash Patel MD, Wellstar Kennestone Regional Hospital, USA

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ABSTRACT

Colorectal cancer (CRC) is a leading cause of cancer-related morbidity and mortality, particularly affecting individuals below 50 years of age in the U.S. Despite the survival benefits conferred by existing screening methods, challenges such as adherence, sensitivity variability, and procedural risks limit their efficacy. This review explores the advent of capsule colon endoscopy (CCE) as a non-invasive screening alternative, capable of circumventing many limitations of traditional methods. CCE utilizes a swallowable imaging device to wirelessly transmit colonic images, showing promise in enhancing patient experience and adherence through its less invasive nature. Technological advancements have improved image quality, incorporated artificial intelligence for image analysis, and refined capsule design, although challenges in visualization and cost remain. Clinical studies report high sensitivity and specificity of CCE for polyp detection, with improvements in detecting lesions in the right colon. Current guidelines recommend careful patient selection and preparation, with ongoing updates as evidence evolves. Future research is focused on improving diagnostic precision, assessing cost-effectiveness, and integrating CCE into screening programs. With its potential to increase screening adherence and reduce CRC incidence, CCE represents a significant development in the field of gastroenterology, meriting continued exploration and optimization in clinical practice.

INTRODUCTION

Colorectal cancer (CRC) poses a serious health challenge globally, being the fourth most diagnosed and third leading cause of cancer death, with an alarming rise in incidence among individuals under 50 in the United States. ^[1,2] Identified risk factors span familial, hereditary, and lifestyle origins-particularly diet, physical activity, and obesity. ^[3,4] Notably, survival rates have climbed due to enhanced screening and early detection methods. ^[5]

Regular CRC screening, critical for early detection, significantly better prognosis and survival, and is strongly advised by health authorities for adults aged 50 to 75. ^[6] High-quality screening, like colonoscopy, is linked to decreased CRC risk and mortality, underscoring the need for effective and accessible screening practices. ^[7-9]

Despite the effectiveness of existing screening techniques, challenges such as low adherence, variability in test sensitivity, cost, and procedure-related risks remain, coupled with a deficiency in detecting right-sided colon cancers.^[10] Capsule colon endoscopy, a non-invasive alternative, has shown potential in addressing these limitations, demonstrating efficacy in colon visualization and lesion detection, including in the right colon.^[11] This method could be particularly beneficial for those reluctant or unable to undergo conventional endoscopy.^[12]

Overview of Colon Capsule Endoscopy Technology:

CCE represents a less invasive alternative to traditional colonoscopy, involving a swallowed capsule with a camera that wirelessly transmits high-resolution images of the colon for examination (Eliakim et al., 2009). Despite not permitting real-time intervention and necessitating thorough bowel preparation, this technology has proven effective for screening, especially where conventional endoscopy is not viable.^[13]

Technological advancements in CCE have greatly improved its potential as a colorectal cancer screening tool, particularly in enhancing image quality,^[14] integrating artificial intelligence for better image analysis,^[15] and refining capsule design for easier ingestion and extended battery life.^[16,17] Despite these improvements, challenges like limited visualization and procedural costs still impede its widespread adoption.^[18]

Patient experience and adherence are critical to the success of CCE. Effective bowel preparation, influenced by patient compliance with dietary and laxative regimens, is paramount for accurate imaging.^[19] The patient's ease with swallowing the capsule, managing the recording device, and returning it for analysis are key for a favorable experience and are reliant on comprehensive patient education and communication from healthcare providers. Continuous assessment of patient satisfaction is necessary to refine CCE and bolster its role in colorectal cancer screening.

Clinical Efficacy of Colon Capsule Endoscopy in Screening:

Colon capsule endoscopy demonstrates high sensitivity and specificity for detecting colorectal polyps, with a second-generation system showing improved accuracy over its predecessor (Eliakim et al., 2009). Sensitivity for polyps larger than 6 mm ranges from 79% to 96%, and specificity from 66% to 97%, varying with polyp size.^[20,21] A meta-analysis further confirms its per-patient polyp detection efficiency,^[22] and AI applications have enhanced diagnostic accuracy, achieving up to 99.1% specificity for protruding lesions.^[23] While these results are promising, discrepancies in detecting smaller and serrated lesions compared to traditional colonoscopy remain,^[24] and it lacks real-time intervention capabilities. Ongoing research aims to refine its diagnostic performance, with studies suggesting comparable efficacy to CT colonography in certain scenarios.^[25] Overall, continued advancements are essential to maximize the utility of colon capsule endoscopy in colorectal cancer screening.

Current Guidelines for Colon Capsule Endoscopy in Colorectal Cancer Screening:

Current guidelines for CCE underscore the importance of careful patient selection, bowel preparation, and endoscopist training in the interpretation of CCE results. The European Society of Gastrointestinal Endoscopy

(ESGE) offers comprehensive guidance on the use of CCE for small-bowel, esophageal, and colonic diseases,^[26] while the American Society for Gastrointestinal Endoscopy (ASGE) suggests CCE as an alternative for patients unable or unwilling to undergo conventional colonoscopy.^[11] National societies may provide additional, localized guidance. With continuous advancements in evidence and technology, these guidelines are subject to updates, necessitating ongoing education for healthcare providers to ensure optimal CCE utilization in practice.

Future Research and Ongoing Trials:

Ongoing research CCE for colorectal cancer screening encompasses various dimensions of its application, including a large Danish randomized controlled trial examining CCE's efficacy within a national screening program,^[27] and trials aiming to enhance CCE image interpretation through artificial intelligence.^[28] Studies also focus on the utility of CCE in patients with prior colorectal surgery to evaluate diagnostic yield and feasibility.^[29] These efforts will clarify the effectiveness and potential role of CCE in screening programs.

Concurrently, future research targets include improving CCE's diagnostic precision for small and serrated lesions,^[30] with AI algorithms poised to elevate detection rates.^[23] Investigations into CCE's application in high-risk groups and post-surgical patients are underway,^[31] alongside assessments of cost-effectiveness and long-term outcomes in comparison to conventional colonoscopy.^[32] Technological advances in capsule functionality, such as controlled insufflation and targeted drug delivery, are anticipated to further broaden CCE's clinical utility.^[33] These research initiatives are directed at optimizing CCE's integration into colorectal cancer screening protocols.

CONCLUSION

Capsule colon endoscopy is a promising non-invasive modality that may complement or offer an alternative to traditional colonoscopy in CRC screening, particularly advantageous for those hesitant or unfit for conventional procedures. Technological enhancements and artificial intelligence are propelling its diagnostic capabilities forward, although challenges in adoption and accuracy persist. Adherence to evolving guidelines and continuous research are vital for the integration of CCE into mainstream screening, potentially reshaping the landscape of CRC prevention and early detection.

REFERENCES

1. Rawla P, T Sunkara, A Barsouk. Epidemiology of Colorectal Cancer: Incidence, Mortality, Survival, and Risk Factors. Prz Gastroenterol. 2019;14(2):89-103.
2. Siegel RL, E Ward, A Jemal. Trends in Colorectal Cancer Incidence Rates in the United States by Tumor Location and Stage, 1992–2008. Cancer Epidemiol Biomarkers Prev. 2012;21(3):411-6.
3. Hagggar F, RP Boushey. Colorectal Cancer Epidemiology: Incidence, Mortality, Survival, and Risk Factors. Clin Colon Rectal Surg. 2009;22(4):191–197.
4. Rachel R Huxley, Alireza Ansary-Moghaddam, Peter Clifton, Sebastien Czernichow, Christine L Parr, Mark Woodward. The Impact of Dietary and Lifestyle Risk Factors on Risk of Colorectal Cancer: A Quantitative Overview of the Epidemiological Evidence. Int J Cancer. 2009;125(1):171-80.

5. Rebecca L. Siegel, Kimberly D Miller, Ann Goding Sauer, Stacey A Fedewa, Lynn F Butterly, Joseph C Anderson, et al., Colorectal Cancer Statistics, 2020. Ca a Cancer Journal for Clinicians, 2020.
6. Calonge N, et al. Screening for Colorectal Cancer: U.S. Preventive Services Task Force Recommendation Statement. Ann Intern Med. 2008;149(9):627-37.
7. Douglas A Corley, Christopher D Jensen, Amy R Marks, Wei K Zhao, Jeffrey K Lee, Chyke A Doubeni, et al. Adenoma Detection Rate and Risk of Colorectal Cancer and Death. N Engl J Med. 2014;370(14):1298-306.
8. Zauber AG. The Impact of Screening on Colorectal Cancer Mortality and Incidence: Has It Really Made a Difference?. Dig Dis Sci. 2015;60(3):681–691.
9. Kirsten Bibbins-Domingo, David C Grossman, Susan J Curry, Karina W Davidson, John W Epling Jr, Francisco A R García, et al., Screening for Colorectal Cancer: US Preventive Services Task Force Recommendation Statement. JAMA. 2016;315(23):2564-2575.
10. Schoen, R.E., et al., Colorectal-Cancer Incidence and Mortality With Screening Flexible Sigmoidoscopy. New England Journal of Medicine, 2012.
11. Eliakim R, SN Adler. Colon PillCam: Why Not Just Take a Pill? Digestive Diseases and Sciences, 2015.
12. Makoto Naganuma, Naoki Hosoe, Takanori Kanai, Haruhiko Ogata. Recent Trends in Diagnostic Techniques for Inflammatory Bowel Disease. Korean J Intern Med. 2015;30(3):271-278.
13. A Stemate, A M Filimon, M Tomescu, L Negreanu. Colon Capsule Endoscopy Leading to Gastrointestinal Stromal Tumor (GIST) Diagnosis After Colonoscopy Failure. BMC Research Notes. BMC Res Notes. 2015;8:558.
14. Pamudurthy V, NA Lodhia, VJ Konda. Advances in Endoscopy for Colorectal Polyp Detection and Classification. Proc (Bayl Univ Med Cent). 2020;33(1):28–35.
15. LaLonde R, et al. Diagnosing Colorectal Polyps in the Wild With Capsule Networks. 2020.
16. Naoki Muguruma, Kumiko Tanaka, Satoshi Teramae, Tetsuji Takayama. Colon Capsule Endoscopy: Toward the Future. Clin J Gastroenterol. 2017;10(1):1-6.
17. Jing Li, Mudan Ren, Jiahui Yang, Yan Zhao, Yarui Li, Dan Zhang, et al. Screening Value for Gastrointestinal Lesions of Magnetic-controlled Capsule Endoscopy in Asymptomatic Individuals. J Gastroenterol Hepatol. 2021;36(5):1267-1275.
18. Lansdorp Vogelaar I, AB Knudsen, H Brenner. Cost-Effectiveness of Colorectal Cancer Screening. Epidemiol Rev. 2011;33(1):88-100.
19. Shashideep Singhal, Sofia Nigar, Vani Paleti, Devin Lane, Sushil Duddempudi. Bowel Preparation Regimens for Colon Capsule Endoscopy: A Review. Therap Adv Gastroenterol. 2014;7(3):115–122.
20. Fanny E R Vuik, Stella A V Nieuwenburg, Sarah Moen, Cristiano Spada, Carlo Senore, Cesare Hassan, et al. Colon Capsule Endoscopy in Colorectal Cancer Screening: A Systematic Review. Endoscopy. 2021;53(8):815-824.
21. Pox C. Controversies in Colorectal Cancer Screening. Digestion. 2014;89(4):274-81.
22. Tue Kjølhede, Anne Mette Ølholm, Lasse Kaalby, Kristian Kidholm, Niels Qvist, Gunnar Baatrup. Diagnostic Accuracy of Capsule Endoscopy Compared With Colonoscopy for Polyp Detection: Systematic Review and Meta-Analyses. Endoscopy. 2021;53(7):713-721.

23. Miguel Mascarenhas, João Afonso, Tiago Ribeiro, Hélder Cardoso, Patrícia Andrade, João P S Ferreira, et al. Performance of a Deep Learning System for Automatic Diagnosis of Protruding Lesions in Colon Capsule Endoscopy. *Diagnostics (Basel)*. 2022;12(6):1445.
24. Douglas K Rex, Samuel N Adler, James Aisenberg, Wilmot C Burch Jr, Cristina Carretero, Yehuda Chowers, et al. Accuracy of Capsule Colonoscopy in Detecting Colorectal Polyps in a Screening Population. *Gastroenterology* . 2015;148(5):948-957.e2.
25. Cristiano Spada, Cesare Hassan, Brunella Barbaro, Franco Iafrate, Paola Cesaro, Lucio Petruzzello, et al. Colon Capsule Versus CT Colonography in Patients With Incomplete Colonoscopy: A Prospective, Comparative Trial. *Gut*. 2015;64(2):272-81.
26. S D Ladas, K Triantafyllou, C Spada, M E Riccioni, J-F Rey, Y Niv, et al. European Society of Gastrointestinal Endoscopy (ESGE): Recommendations (2009) on Clinical Use of Video Capsule Endoscopy to Investigate Small-Bowel, Esophageal and Colonic Diseases. *Endoscopy*. 2010;42(3):220-7.
27. Ulrik Deding, Thomas Bjørsum-Meyer, Lasse Kaalby, Morten Kobaek-Larsen, Marianne Kirstine Thygesen, Jeppe Buur Madsen, et al. Colon Capsule Endoscopy in Colorectal Cancer Screening: Interim Analyses of Randomized Controlled Trial CareForColon2015. *Endosc Int Open*. 2021;9(11):E1712-E1719.
28. Sarah Moen, Fanny E R Vuik, Ernst J Kuipers, Manon C W Spaander. Artificial Intelligence in Colon Capsule Endoscopy—A Systematic Review. *Diagnostics (Basel)*. 2022;12(8):1994.
29. Lasse Kaalby, Ulrik Deding, Morten Kobaek-Larsen, Anne-Line Volden Havshoi, Erik Zimmermann-Nielsen, Marianne Kirstine Thygesen, et al. Colon Capsule Endoscopy in Colorectal Cancer Screening: A Randomised Controlled Trial. *BMJ Open Gastroenterol*. 2020;7(1):e000411.
30. Friedel D, RJ Modayil, SN Stavropoulos. Colon Capsule Endoscopy: Review and Perspectives. *Gastroenterol Res Pract*. 2016;2016:9643162.
31. Claudio Fiorillo, Giuseppe Quero, Fabio Longo, Pietro Mascagni, Michel Delvaux, Didier Mutter. Capsule Endoscopy Versus Colonoscopy in Patients With Previous Colorectal Surgery: A Prospective Comparative Study. *Gastroenterology Res*. 2020;13(5):217–224.
32. C Hassan, A Zullo, S Winn, S Morini. Cost-Effectiveness of Capsule Endoscopy in Screening for Colorectal Cancer. *Endoscopy*. 2008;40(5):414-21.
33. Trisha Pasricha, Byron F Smith, Victoria R Mitchell, Brian Fang, Erik R Brooks, Jason S Gerding, et al. Controlled Colonic Insufflation by a Remotely Triggered Capsule for Improved Mucosal Visualization. *Endoscopy*. 2014;46(7):614-8.