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Colon capsule endoscopy – Current role in large bowel diagnostics and gain from advances in artificial intelligence

Artificial intelligence in colon capsule endoscopy

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Abstract

Colon capsule endoscopy (CCE) was introduced nearly two decades ago. Initially, it was limited by poor image quality and short battery time, but due to technical improvements, it has become an equal diagnostic alternative to optical colonoscopy (OC). Hastened by the Covid-19 pandemic, CCE has been introduced in clinical practice to relieve overburdened endoscopy units and move investigations to out-patient clinics. A wider adoption of CCE would be bolstered by positive patient experience, as it offers a diagnostic investigation that is not inferior to other modalities. The shortcomings of CCE include its inability to differentiate adenomatous polyps from hyperplastic polyps. Solving this issue would improve the stratification of patients for polyp removal. Artificial intelligence (AI) has shown promising results in polyp detection and characterization to minimize incomplete CCEs and avoid needless examinations. Onboard AI appears to be a needed application to enable near-real-time decision-making in order to diminish patient waiting times and avoid superfluous subsequent OCs. With this letter, we discuss the potential and role of AI in CCE as a diagnostic tool for the large bowel.

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Core Tip: Colon capsule endoscopy (CCE) generates a vast amount of image material – currently, this material must be assessed manually. Artificial intelligence (AI) as an adjunct to CCE has been reported as having high accuracy for detecting colonic lesions. Future studies need to evaluate AI algorithms for estimating the likelihood of neoplasia and predicting which patients are most likely to benefit from CCE. Onboard capsule

intelligence has the potential to generate result reports immediately after completed examinations.

TO THE EDITOR

We read with interest the in-depth review by Kröner *et al*. The authors presented a thorough account of the status and knowledge of artificial intelligence (AI) in everyday practice in gastroenterology [1]. As we apply AI in picture analysis of colon capsule endoscopy (CCE), we feel obliged to offer some relevant insights. The Covid-19 pandemic has accelerated the clinical adoption of CCE as an alternative first-line diagnostic procedure to optical colonoscopy (OC) [2]. CCE is a painless, low-risk procedure that can be performed in the patient's home with minimal contact with healthcare workers and/or other patients, therefore abiding (when possible) by the distancing measures recommended to contain the spread of Covid-19.

Furthermore, CCE is seen as a measure to relieve the pressure on overburdened endoscopy units with long waiting times for OC. The Scottish Capsule Programme has implemented CCE in a large-scale roll-out to patients presenting with lower gastrointestinal symptoms to their general practitioners and found to be eligible for colonic investigation [3]. The programme enables effective upfront screening at the community level to address increasing demand and capacity pressure within the National Health Service.

Until recently, the clinical implementation of CCE has been hampered by low completion rates compared to OC. A significant drawback for CCE is its reliance on extensive orally administered bowel cleansing preparations to gain adequate visualization of the mucosa, as, unlike OC, water wash and suction are not possible. Although research into optimizing and standardizing bowel preparation regimens is ongoing, to date it has failed to meet the minimum standard of 90% for OC [4]. A recent systematic review and meta-analysis of 46 studies including 5,000 patients showed that CCE's (pooled) adequate colon cleanliness rate (ACCR) was only 77% [5]. Therefore, further studies aiming to improve CCE's ACCR are mandatory. Another way to achieve

more conclusive CCE examinations is to enhance our ability to predict patients at high risk of an insufficient colon cleanliness level. AI algorithms based on demographic data are one possible solution. We are currently running a large randomized trial in Denmark (CFC2015) in which 2,015 citizens are allocated to CCE. After the study is completed in Summer 2022, we plan to create algorithms for just such a purpose [6]. The cost-effectiveness of CCE needs to be improved before wider clinical adoption is considered. Hassan *et al* found that improved compliance in the general population is mandatory to make CCE cost-effective compared to OC [7].

CCE produces many images, and reading them is very time-consuming and monotonous, increasing the risk of missing important lesions. Hence, the development of AI-based tools to assist readers is needed. Saraiva *et al*, in a recent article, developed a convolutional neural network (CNN) based on AI. They found that it could detect protruding lesions in the colon with a sensitivity of 90.7% and a specificity of 92.6% [8]. Furthermore, Blanes-Vidal *et al* developed a CCN for the autonomous detection of colorectal polyps based on 255 participants from the Danish National Bowel Cancer Screening Programme who underwent CCE [9]. The algorithm showed a sensitivity and a specificity of 97.1% and 93.3%, respectively. To avoid unnecessary OC after CCE, it is essential to differentiate between hyperplastic polyps (HPs) and adenomatous polyps (APs). By applying flexible spectral imaging colour enhancement (FICE), Nakazawa *et al* differentiated HPs from APs with a sensitivity of 91.2% and specificity of 88.2% [10]. Further research is needed to detect sessile serrated lesions using AI-assisted CCE.

The delay between capsule egestion and the completion of video reading and report writing is currently two days. Onboard capsule intelligence has the potential to make near real-time assessments of colonic pathology, creating a report almost immediately after CCE completion. The authors of this letter aspire to the development of onboard integrated AI to make CCE an expeditious diagnostic tool comparable to OC.

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