Editorial

Artificial intelligence and the endoscopist's skill and proficiency for polyp detection: no winner one without the other!

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Adenoma detection rate (ADR) represents the most widely accepted quality metric of colonoscopy and it has been validated as an independent predictor of the risk of interval colorectal cancer (CRC) after screening colonoscopy (1). Besides, it has also been demonstrated that increasing ADR translates into a reduced risk of interval CRC by individual endoscopist, with an approximately 6% relative reduction for each 1% increase in ADR (2). As ADR largely varies among different endoscopists (1,3), reflecting differences in colonoscopy performance, many studies in the literature have evaluated new technologies to improve it, showing conflicting and sometimes disappointing results.

The study by Urban *et al.* (4), published on *Gastroenterology*, makes a further step in the future by evaluating the application of a deep learning model for computer-assisted image analysis [convolutional neural networks (CNNs)] to increase polyp detection, as a surrogate of ADR. In detail, the Authors developed and trained CNNs to detect polyps using a representative set of 8,641 polyp pictures from screening colonoscopies identified from more than 2,000 patients, achieving an accuracy of 96.4%. The models were subsequently tested on 20 colonoscopy videos with an overall duration of five hours. Furthermore, highly-experienced endoscopists were asked to detect all polyps in 9 de-identified colonoscopy videos, selected from archived video studies, with or without benefit of the CNN overlay; their performances were compared with CNN ones using CNN-assisted expert review as the reference. In the analysis of colonoscopy videos in which 28 polyps were removed, 4 expert reviewers identified 8 additional polyps without CNN assistance that had not been removed and identified during live examinations and 9 more polyps with CNN assistance. CNN identified all polyps detected by expert reviewers, with a false-positive rate of 7%. The Authors concluded that CNN was able to identify polyps with a very high cross-validation accuracy in a set of colonoscopy pictures and also to real-time detect and localize polyps using an ordinary desktop equipment with a contemporary graphics processing unit. According to the Authors the use of artificial intelligence for polyp detection may represent a great promise in helping to close the gap between ADR and true adenoma prevalence, especially for colonoscopists with low baseline ADR.

So, if these results will be confirmed in real-time validation studies, will it be possible to disregard the human touch? Probably not, or at least not at all. Actually, the polyp and, even more, the adenoma detection during colonoscopy is a multistep process mainly depending on three main human contributors, which all concur to the quality of the examination.

First, the skill to bring the polyp into the field of view, which mainly depends on withdrawal technique, namely the ability of carefully inspecting the mucosa during the scope withdrawal by an adequate lumen distension, mucosal cleansing and mucosal exposure behind colonic folds. Technique, albeit difficult to be objectively assessed, is strictly endoscopist-related and represents a powerful indicator in differentiating high and low adenoma detectors, even more important than withdrawal time (5).

Second, the ability to focus attention on a lesion that is in the field of view. Studies evaluating the role of a second observer during colonoscopy in detecting adenomas suggest that even when the polyp is located within the field of view, the endoscopist may not perceive its presence (6,7). This may be due to "inattentional blindness", when we fail to see something if our attention is focused somewhere else, or "change blindness", when changes are missed during eye movements or interruptions of visual scanning. Differences in visual tracking patterns between colonoscopists may also be a factor. At this purpose, studies evaluating the impact of endoscopists' visual gaze patterns on ADR by using the eye-tracking technology, an objective tool that detects differences in viewing patterns, defined distinct VGPs that are associated with expert behavior (8,9).

Third, once that a lesion is put into the appropriate field of vision and correctly identified, the capacity to differentiate it from the normal surrounding mucosa or other subtle mucosal lesions with no clinical relevance. This mainly depends on the endoscopist experience and culture. The case of sessile serrated lesions, which have always existed but ever overlooked until recently, represents a relevant example of this situation.

How can the computer-assisted image analysis influence this multistep process? If it can be hypothesized that it can attenuate the endoscopists' deficiencies in attention or visual gaze patterns or fatigue, this new technology cannot compensate for poor colonoscopy technique. Indeed, the advantage of deep learning is just computational, as the machine can detect only what the colonoscope sees. Besides, the adoption of this new technology will not undo the role of the endoscopist in the correct interpretation of what the machine identifies, at least until future generations of deep learning polyp recognition software will substantially minimize the false-positive rate. As demonstrated in the present study, adding new training samples not only with more polyps, but also with random artifacts, such as water, air, bubbles, fecal matter and low quality blurred frames, could decrease the rate of false positive images.

In spite of that, the use of computer-aided detection systems for polyp detection during colonoscopy is extremely exciting and we are sure that in the near future these technologies will be part of modern endoscopy platforms.

However, at present some caution is needed as the study by Urban *et al.* still represents a feasibility study, and generalization to real-time use may be limited by several factors, for example the unknown effects of CNN on inspection behavior by the endoscopists (i.e., the availability of a highly-performing computerized support might reduce the operators' attention during colonoscope withdrawal and thus nullify the potential advantages of the new technology) or their acceptance of this auxiliary system, which still is suboptimal in other setting (i.e., radiology). Again, the issue of adjunctive costs for this technology is not negligible, either direct or indirect, due to an increase of procedure length and histology costs related to the problem of false positive results, which might even be more critical in case of poor bowel preparation. Future work must continue to develop methods that balance a high sensitivity with low latency and improved false positive rates, but at present the main efforts must still be paid for improving colonoscopy quality and endoscopists' training.

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