NEW METHODS

Computerized feedback during colonoscopy training leads to improved performance: a randomized trial

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Background and Aims: Simulation-based training in colonoscopy is increasingly replacing the traditional apprenticeship method to avoid patient-related risk. Mentoring during simulation is necessary to provide feedback and to motivate, but expert supervisors are a scarce resource. We aimed to determine whether computerized feedback in simulated colonoscopy would improve performance, optimize time spent practicing, and optimize the pattern of training.

Methods: Forty-four participants were recruited and randomized to either a feedback group (FG) or a control group (CG). Participants were allowed 2 hours of self-practice during which they could practice as they saw fit on 2 different cases: 1 easy and 1 difficult. The CG practiced without feedback, but the participants in the FG were given a score of progression every time they reached the cecum. All participants were tested on a different case after end of training. The primary outcome was the progression score in the final case, and secondary outcomes were time spent practicing and the training pattern.

Results: Regression analysis adjusting for sex was done because of an uneven sex distribution between groups ($P = .026$) and significantly higher performance scores by men (37.6, standard deviation [SD] 25.9) compared with women (19.7, SD 18.7); $P = .012$. The FG outperformed the CG in the final case, FG scoring 14.4 points (95% confidence interval [CI], 1.2-27.6) more than the CG; $P = .033$, and they spent more time practicing, FG practicing 25.8 minutes (95% CI, 11.6-39.9) more than the CG; $P = .001$. The FG practiced more on the easy case and reached the cecum 3.2 times more (95% CI, 2-4.5) during practice ($P < .001$).

Conclusions: Our findings of this study revealed that an automatic, computerized score of progression during simulated colonoscopy motivates the novices to improve performance, optimizes time spent practicing, and optimizes their pattern of training. (Clinical trial registration number: NCT03248453.)

Colonoscopy is the criterion standard for diagnosing colorectal diseases. Novices handling the colonoscope impair patient-related safety, diagnostic accuracy, and cecum intubation rates.[1,2] Traditionally, the training is done at the bedside, but simulation-based training is increasingly replacing the initial introduction to avoid patient-related risks.[3] Virtual reality colonoscopy simulators can provide the user with feedback,[3,4] but they lack tactile sensory realism. In contrast, physical simulators can be more realistic, but they lack the feedback

Abbreviations: CG, control group; CoPS, colonoscopy progression score; FG, feedback group.

DISCLOSURE: *The intellectual property rights for the algorithm for analyzing colonoscope progression are protected by patent by Professor Lars Konge, Morten Bo Søndergaard Svendsen, and Professor Lars Bo Svendsen. All other authors disclosed no financial relationships relevant to this publication.*

This study was funded by The Capital Region of Denmark.

0016-5107/$36.00
https://doi.org/10.1016/j.gie.2018.07.008

Received December 13, 2017. Accepted July 11, 2018.

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mechanism. Feedback is central in motivating and guiding the learner and is essential for all involved in education. How and when feedback is applied affects and motivates with different results.[5] Evidence supports findings that feedback given by instructors compared with feedback from a simulator helps to increase performance,[5] but drawbacks such as time spent by instructors and observer bias have led to the need for less-expensive, automated, and objective systems.

Predefined proficiency levels based on expert performances and not a fixed training time currently are the end goal for novices.[6,7] Previous studies have explored how skills gained in a simulation-based setting transfer to the clinic, but they have not focused on how feedback affects performance during training.[3,4,8] Currently, no one has investigated the influence on performance of receiving computerized feedback during simulated colonoscopy on a physical model.

The colonoscopy progression score (CoPS) is an automated and objective computerized score. CoPS was created to assess the progression of the tip of the endoscope by tracking it through the colon and calculating the progression score by using a patented algorithm. The system has been validated in both a simulation-based and a clinical setting,[9,10] and was found to be positively correlated with patient-related pain during a colonoscopy.[11]

We aimed to determine whether feedback from a computerized system could motivate and improve the novices' performance during self-practice in simulated colonoscopy on a physical model. We hypothesized that CoPS as feedback on a physical model versus no feedback motivates novices to improve performance, optimize time spent practicing, and optimize their pattern of training.

METHODS

Participants

Forty-four volunteer participants (interns and junior residents) were recruited for inclusion into this study. Participants were identified from mailing lists of graduate students within the previous 2 years and advertisements on Web sites at the Copenhagen Academy for Medical Education and Simulation. Participants were included if they had no former experience with simulated or clinical colonoscopy. Demographics are shown in Table 1. All participants gave oral and written informed consent before enrollment. Participants were not compensated for their participation.

The simulator and equipment

The Kyoto Kagaku Colonoscopy Training Model (Kyoto Kagaku Co Ltd, Kyoto, Japan), a realistic physical phantom model, was used as a model for the human colon. The phantom can be configured into 6 standard cases, each with a different formation and difficulty. Two cases were chosen for training, 1 easy (case 1, no loops) and 1 difficult (case 4, alpha loop with a very flexible sigmoid colon), and the final case for testing (case 3) had a more classic fixed alpha loop in the sigmoid colon. We used Magnetic Endoscope Imaging (MEI ScopeGuide; Olympus Optical, Tokyo, Japan) to record the route of the colonoscope (CF-H180DL; Evis Exera II video center CV-180, Olympus Medical System Ltd, Tokyo, Japan) when participants performed colonoscopies. The established CoPS was measured after each colonoscopy.[9,10] The CoPS is based on the movement of the tip of the colonoscope as recorded by the MEI displayed on a monitor (Fig. 1). The score is reduced if the tip returns to a position already visited and increased if the tip continuously visits new positions (indicating progression along the colon).

Intervention and randomization

Participants had no former experience with colonoscopy and were introduced by the same instructor to the colonoscope and the simulator and were taught basic skills to handle the colonoscope correctly. All participants were given a standardized introduction of 30 minutes and randomized (by the instructor) in 1:1 ratio to either the feedback group (FG) or the control group (CG). One investigator prepared numbered, sealed, opaque envelopes for the randomization. Both groups were allowed a maximum of 2 hours of practice without supervision. Participants were free to switch between the easy and the difficult case or stop the practice session and proceed to the final test whenever they wanted.

Participants in the FG were given the CoPS as the only feedback each time they reached the cecum. They were encouraged to score as high as possible, and for comparison a leaderboard presenting high scores from experts in colonoscopy was present. The CG was not given any feedback during practice.

All participants performed once on the final case for which they were allowed a maximum of 30 minutes to reach the cecum. The CoPS in the final case was registered as zero if the participants did not reach the cecum within the time limit. Neither of the groups was aware of the primary outcome measure in the final case. The participants in the FG were asked to complete a questionnaire on motivation after the test. Figure 2 gives a summary of the study design.

Sample size

The sample size was calculated based on data from a previous trial.[9] We assumed that participants in the FG would have a mean score of 75 points and in the CG 40 points, with a standard deviation (SD) estimated to be 36 points. A significance level of 5% and a power of 0.9 required 22 participants in each group.

Performance measures

The primary outcome was the actual CoPS in the final case, and the secondary outcomes were as follows: (1)