

Title: Measuring Force Transmission During Colonoscopy: Development of a Novel Training Device

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Structured Abstract:

Background: Colonoscopy is one of the most common procedures performed by gastroenterologists and surgeons in the diagnosis and management of colonic pathology. Since the advent of colonoscopy, deaths from colorectal cancer have decreased by up to 70%. However, colonoscopy is not without risk. The most feared complication is that of perforation; furthermore, colonoscopy is uncomfortable for patients.

There is a well-described decline in complication rates with experience. The number of procedures performed during training is thus often cited as a surrogate marker of competency. In the era of trainee work hour restrictions, it is difficult, if not impossible, to achieve the high procedural numbers recommended. Focus has now shifted to improved quality of training, rather than quantity. Simulation has become widely embraced by the medical community to provide a safe environment for trainees to develop and practice technical skills without risk to patients. Existing colonoscopy simulators are aimed at negotiating the scope to the end of the bowel with the lumen in view, but do not take into account force transmitted from the colonoscope tip and loops to the colon wall.

We hypothesize that expert endoscopists utilize safe techniques, which minimize the amount of force transmitted to the bowel wall compared to novices. Our research aims to develop a device to monitor force transmission, and provide feedback to the endoscopist.

Methods: Development of a model to assess force applied to the bowel wall included trialing the application of strain sensors to the simulated training colon model (Kyoto Kagaku, KKM40), as well as optical and electromagnetic marker tracking. We will define the relationship between endoscopic skill and force application by having both expert and novice endoscopists complete procedures using the model.

Results: Electromagnetic tracking markers show the most promise for our application. They were applied to a commercially available training model of the colon at specific anatomic segments at known risk of perforation (sigmoid, splenic flexure, transverse, hepatic flexure). Measurements of average and maximal translational motion can be recorded with this model and used as a surrogate marker for force application.

Discussion: Our device shows promise as a supplement to current simulators, to alert users of unsafe forces during colonoscopy, encouraging the adoption of safe techniques. Future work will include testing the construct validity of the model by comparing force transmission when experts are compared to novices. Further, comparison to current, validated endoscopic assessment tools will show the potential added value of force transmission as a metric of endoscopic skill.