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Strategies to manage the difficult colonoscopy

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Abstract
During endoscopy, an endoscopist is inevitably faced with the occasional "difficult colonoscopy," in which the endoscopist finds it challenging to advance the endoscope to the cecum. Beyond optimization of technique, with minimized looping, minimal insufflation, sufficient sedation, and abdominal splinting when needed, sometimes additional tools may be needed. In this review, we cover available techniques and technologies to help navigate the difficult colonoscopy, including the ultrathin colonoscope, rigidizing overtube, balloon-assisted colonoscopy and the abdominal compression device.

Key Words: Difficult colonoscopy; Incomplete colonoscopy; Overtube; Water immersion; Colonoscopy; Balloon enteroscopy

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Core Tip: In all colonoscopies, we recommend optimizing technique, with minimal insufflation, sufficient sedation, minimal looping, water immersion, and having staff apply abdominal pressure when needed. When the cecum cannot be reached despite this,

we consider utilization of additional tools, including overtube or specialized endoscope (*e.g.,* ultrathin colonoscope).

INTRODUCTION

The American Society for Gastrointestinal Endoscopy and American College of Gastroenterology recommends cecal intubation of 90% in all colonoscopies and 95% for screening colonoscopies[1]. During endoscopy, an endoscopist is inevitably faced with the occasional "difficult colonoscopy," in which the endoscopist finds it challenging to advance the endoscope to the cecum. At times, the cecum is not reached, leading to an incomplete colonoscopy. In this review, we cover available techniques and technologies to help navigate the difficult colonoscopy. We will not be focusing on specific techniques in managing issues such as looping, as this has been extensively covered in articles and books such as by Haycock *et al*[2] and Rodrigues-Pinto[3].

FACTORS FOR DIFFICULT COLONOSCOPY

Several factors for increased cecal intubation time have included female sex[4,5], inadequate bowel preparation[4-7], older age[5-7] constipation[6], lower body mass index[5,8], patient pain[5], previous hysterectomy[4,8], diverticular disease in women[9,10]. Unfortunately, the data available for incomplete colonoscopy is significantly more sparse. This may likely be related to difficulties of evaluating this, given overall lower frequency of incomplete colonoscopy, with most endoscopists only encountering a few a year. In a study by Koido *et al*[11], evaluating 11812 patients that underwent colonoscopy at Juntendo Hospital (Tokyo, Japan), cecal intubation was 95.0%. Risk factors for incomplete colonoscopy included female sex, history of prior abdominal or pelvic surgery, increased age (≥ 60), inflammatory bowel disease, and poor bowel preparation. In a similar study by Shah *et al*[12], utilizing the Ontario Health Insurance Plan reviewing 311608 colonoscopies, of which 13.1% were incomplete. Factors identified were similar to the Koido *et al*[11] study (older age, female sex, prior abdominal or pelvic surgery). In addition, Shah *et al*[12] found colonoscopies perfomed in a private center had increased

odds of incomplete colonoscopy compared to at an academic hospital (OR: 3.57, 95%CI: 2.55-4.98)[12].

OPTIMAL TECHNIQUE

While tools are available to help with difficult colonoscopy, it is important to try to always utilize optimal technique during colonoscopy, with minimized looping, minimal insufflation, sufficient sedation, and abdominal splinting when needed[2,3]. In the case of a difficult colonoscopy, prior to considering utilizing different or additional devices, we recommend trying to classify the issue and tackle it appropriately. Difficulty reaching the cecum during colonoscopy may be due to inadequate sedation, a redundant/Looped colon, tortuous anatomy, or a hernia. Patients who vigorously contract their abdominal musculature when experiencing pain during colonoscopy may hinder advancement of the scope. In this situation providing adequate sedation and analgesia, sometimes with the assistance of an anesthesiologist, may facilitate completion of the procedure. The redundant/Looped colon may be best managed with adult colonoscope (in comparison to a pediatric colonoscope), with water immersion or water exchange technique during insertion, and with early and effective abdominal splinting. An angulated/tortuous colon is usually easier to navigate with a pediatric colonoscope, or at times an ultrathin colonoscope or enteroscope, which can allow for improved navigation around tight turns. In this case, underwater immersion may also help straighten the colon. Abdominal wall hernias are best managed with adequate counter pressure to prevent the hernia from billowing out. Underwater immersion can also be effective in assisting with this[13]. Finally, large inguinal hernias containing colon should be reduced if possible prior to colonoscopy and constant pressure can be applied to prevent the colon from re-entering the hernia during the procedure. In cases of difficult colonoscopy despite optimized technique, alternative/additional tools may be required.

DEVICES TO MANAGE DIFFICULT COLONOSCOPY

Ultrathin colonoscope

Ultrathin colonoscopes [*e.g.*, EC-530XP (7.0 mm diameter); Fujifilm Corp, Tokyo, Japan] have been found in a randomized controlled trial (RCT) evaluating its use compared to pediatric colonoscope to achieve lower pain as well as trend towards higher cecal intubation rate (97.4% *vs* 92.1%, $P = 0.36$) in female patients ≥ 70 years of age[14]. Ultrathin colonoscope can also be useful in navigating stenotic colons. In one study by Ito *et al*[15], in 100 patients with stenotic colorectal cancer (CRC) in which a standard pediatric colonoscope could not traverse the CRC stenosis, cecal intubation was achieved for 58% of patients utilizing the ultrathin colonoscope. This has similar been demonstrated in Crohn's strictures[16].

Rigidizing overtube

In August 2019, the Pathfinder Endoscope Overtube (Neptune Medical, Burlingame, Calif, United States) was approved by the United States Food and Drug Administration (Figure 1)[17]. With the use of an overtube that can be flexible or rigid depending on application of a vacuum, the overtube has been found to assist in difficult colonoscopies[18]. In a retrospective case series, in 12 patients in which the overtube to assist with incomplete colonoscopy, the cecum was reached in all cases, with median cecal time of 6 minutes (IQR 4-7.25 min)[19].

G-EYE colonoscope and NaviAid AB

In April 2020, G-EYE® colonoscope (SMART Medical, Ra'anana, Israel) achieved FDA approval. The G-EYE® colonoscope involves the remanufacturing of a reusable balloon at the bending section of the colonoscope. The balloon can be inflated and deflated using the NaviAid™ SPARKC inflation system, allowing for more controlled maneuvering around folds. In addition, the NaviAid AB device is a through-the-scope inflatable balloon which can be inserted through a standard adult colonoscope (requires working channel minimum 3.7 mm). In 2015, Ali *et al*[20] performed a retrospective multicenter study evaluating utility of the NaviAid AB device in enteroscopy (either anterograde or retrograde). While the indications of these endoscopic procedures did not include

difficult or incomplete colonoscopy, it is interesting to note that of the 33 retrograde cases, average depth of insertion was 89 cm (range 20-150 cm) proximal to the ileocecal valve utilizing a push-pull technique[20]. In a smaller study involving 9 patients, NaviAid AB device was found to be safe and successfully lead to completion of all colonoscopies[21].

Abdominal compression device

Given the importance of abdominal splinting during endoscopy but its burden on staff[2], the abdominal compression device (ColoWrap, LLC, Durham, NC) has been found to assist with decreasing cecal intubation time and improvement in need of additional manual compression[22,23]. While an abdominal compression device may assist in difficult colonoscopy, it has not been specifically studied in incomplete colonoscopy.

Stiffening wire

In 1994, Kasmin *et al*[24] described a technique of colonoscopy "over the forceps." In this technique, the forceps is advanced 10cm beyond the colonoscope, and the colonoscope jiggled forward over the forceps with tension on the forceps.In an RCT evaluating the utility of a standard as well as firm stiffening wire (Zutron Medical™, Lenexa, KS, United States), there was no difference in cecal intubation rate of unaided colonoscope (81.1%), standard wire (71.1%), and firm wire (74.3%) However, use of the wire for endoscopies with the unaided colonoscope that were unable to reach cecum led to improvement in cecal intubation from 81.1% to 97.3% ($P = 0.0313$)[25].

Balloon-assisted colonoscopy

While developed primarily for evaluation of small bowel, single-balloon and double-balloon enteroscopy has been utilized to help manage incomplete colonoscopy. Balloon-enteroscope technology utilizes the balloon to help pleat and stabilize the colon, allowing the colon to be shortened and thereby allowing further endoscope advancement[26]. In a randomized controlled trial by Despott *et al*[10] in 2017, patients defined as technically difficult (based on a scoring system utilizing factors for difficult colonoscopy) were

randomized to double-balloon colonoscopy or conventional colonoscopy. With 22 patients in each arm, double-balloon colonoscopy was able to achieve similar cecal intubation time (17.5 *vs* 14 min, $P = 0.18$) but had improved patient discomfort and pain scores[10]. In a meta-analysis by Tan *et al*[27], evaluating single and double-balloon enteroscopy in the context of previous incomplete colonoscopy, cecal intubation rate was 97%. There was little difference between SBE and DBE in cecal intubation rate (98% *vs* 97%, $P = 0.63$) and time to cecum (22 *vs* 19 min, $P = 0.40$).

WHAT IS THE CECUM CAN STILL NOT BE REACHED?

Under circumstances in which the cecum cannot be reached despite techniques described above, non-invasive options can be considered, including computed tomography (CT) colonography or colon capsule endoscopy. Particularly in elderly patients or those with significant comorbidities, after discussion with the patient a decision not to pursue additional testing may also be appropriate. In a meta-analysis by Deding *et al*[28], while completion rate of CT colonography was higher than colon capsule endoscopy (98 *vs* 76%), colon capsule endoscopy had increased detection of polyps of any size (37 *vs* 10%). Of note, colon capsule in the studies referenced were all utilizing PillCam (1st or 2nd Generation). In a randomized controlled trial by Sali *et al*[29] comparing CT colonography with three rounds of FIT (every 2 years), there was low participation overall for both CT colonography (26.7%) and all three rounds of FIT (33.4%) (though 64.9% participated in at least one FIT)[29]. In reviewing patients who completed screening, advanced neoplasia was detected at a higher rate with CT colonography compared to FIT (5.2 *vs* 3.1%, $P = 0.0002$).

Our experience

In our experience, when we encounter a referral for incomplete colonoscopy, we try to first understand the issue leading to incomplete colonoscopy. In general, our referring endoscopists are extremely experienced, and oftentimes will document the issue leading to difficult colonoscopy. If patient intolerance was an issue, then we will have the

procedure performed under monitored anesthesia care instead of moderate or conscious sedation. If the procedure was notable for tortuous colon with significant diverticulosis, we may start with a pediatric colonoscope and if needed switch to an ultrathin colonoscope or upper endoscope, with the upper endoscope being less preferred given its shorter length. If the procedure was notable for significant looping, we will request the help of our more experienced staff to help with abdominal splinting and may be more inclined to utilize overtube technology, including the single or double-balloon enteroscope, or the rigidizing overtube. In our experience, a "long" colon usually occurs in combination with tortuosity or looping, or both. As such, utilization of the techniques above would be helpful in managing the long colon. However, in the absence of tortuosity or looping, one could consider utilization of the enteroscope (without the overtubes for the additional length), or utilization of single or double-balloon enteroscope. In all these cases, we tend to perform the majority of the colonoscopy with water immersion.

CONCLUSION

In all colonoscopies, we recommend optimizing technique, with minimal insufflation, sufficient sedation, minimal looping, water immersion, and having staff apply abdominal pressure when needed. When the cecum cannot be reached despite this, we consider utilization of additional tools, including overtube or specialized endoscope (*e.g.*, ultrathin colonoscope). In the rare instance in which the cecum cannot be reached despite best effort including referral to specialized center, consideration can be made for non-invasive imaging (CT colonography or colon capsule endoscopy).

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