Impact of water filling on terminal ileum intubation with a distal-tip mucosal exposure device

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Abstract:

Background and aims:

Endocuff improves detection at colonoscopy, but seems to impede terminal ileal (TI) intubation. We assessed the impact of Endocuff Vision (EV) on TI intubation using adult or pediatric colonoscopes. Second, we evaluated whether filling the cecum with gas versus water affected the impact of EV on TI intubation.

Methods:

Using a prospectively recorded quality control database, we explored the impact of Endocuff Vision (EV) on TI intubation in ≤1 minute. We used adult and pediatric colonoscopes and tested the effect of cecal filling with gas versus water. If the initial attempt failed, then the alternative (water vs gas) was tried as a rescue method.

Results:

TI intubation in ≤1 minute occurred in 91% of colonoscopies without EV versus 65% with EV, but the use of the pediatric colonoscope with EV had a higher TI intubation success rate in ≤1 minute compared with the adult colonoscope with EV (73% vs. 57%, p=0.043). TI intubation in ≤1 minute was more successful with EV if water filling of the cecum was used rather than gas (74% vs 56%, p = 0.019), but the benefit of water filling was limited to the adult colonoscope with EV. When EV was in place, water filling was more successful as a rescue method of TI intubation (58% vs 21%, p = 0.011)

Conclusions:

Endocuff Vision (EV) adversely affects TI intubation, particularly for adult colonoscopes. Water filling of the cecum mitigates the impact of EV on TI intubation with adult colonoscopes.

Introduction:

Endocuff (Arc Medical Design, Ltd, Leeds, United Kingdom) is a distal colonoscope attachment designed to improve mucosal exposure and adenoma detection. In meta-analyses, the adenoma detection rate (ADR) increases by an average of 7% with use of Endocuff [1]. Endocuff has been replaced by Endocuff Vision (EV) (Figure 1), a similar device to the original Endocuff but with a single row of fingers that are longer than in the original device [2]. Use of Endocuff and EV have been shown to speed colonoscope insertion to the cecum [3-5], and to allow faster withdrawal without a reduction in detection [5-8].

Despite the advantages, use of Endocuff or EV also has disadvantages. The device increases the diameter of the colonoscope tip, so that patients with narrowed sigmoid colons, usually from diverticular disease, may require removal of the device to pass the sigmoid [9]. Secondly, some data, as well as a widespread anecdotal impression, indicate that the devices slow down terminal ileal intubation and in some cases prevent it [10, 11]. In patients with a clear indication for terminal ileal intubation, such as Crohn's disease, or a patient with unexplained abdominal pain and diarrhea [12], the use of EV could be considered contraindicated.

In routine colonoscopy patients undergoing screening and surveillance examinations, the advantages of EV arguably outweigh the disadvantages. Nevertheless, some endoscopists prefer to routinely intubate the TI.

In an exploratory quality assessment, we assessed the success rate of TI intubation in ≤1 minute using adult and pediatric Olympus colonoscopes with and without use of EV. We varied the use of gas filling of the cecum and right colon segment versus water filling. Water filling of the right colon segment has the property of relaxing the ileocecal valve, and often allowing the orifice of the valve to turn distally and allowing a more en face approach, compared with gas filling of the right colon segment.

Methods:

From May 24, 2019 to July 24, 2019, we recorded TI intubation information for consecutive patients who underwent either a standard colonoscopy or colonoscopy with EV using either an adult or pediatric colonoscope. Patients were excluded if they had a specific indication to intubate the TI (eg, Crohn's disease or unexplained abdominal pain and diarrhea). Patients with right hemicolectomy were also excluded. More than 98% of the procedures were performed using Olympus 190 series colonoscopes. Some of these patients had their insertion done using gas (carbon dioxide) insufflation and some had part or all of the insertion under water. All patients were sedated using propofol.

The first study goal was to assess the impact of EV on TI intubation success using adult or pediatric colonoscopes. Concurrently we evaluated whether water filling of the cecum versus gas filling affected the success of TI intubation. In all patients the endoscopist (DKR) attempted to intubate the TI, with a maximum of 1 minute allowed to make the attempt. If the attempt was a failure, he immediately switched to the alternative method of TI intubation, for example a failure with gas insufflation would trigger an attempt with water and vice versa.

Adult versus pediatric colonoscopes were selected based on known severe sigmoid diverticular disease or older age (endoscopist tended to select pediatric colonoscope), and patient recruitment to a different study in which videos were collected for training an artificial intelligence program (we were in a phase of this video collection where pediatric colonoscopes were preferred). The EV was used in most cases unless there was significant diverticular disease. The use of water filling or gas insufflation first was alternated on most procedure days.

A research assistant recorded patient demographics, colonoscope used, use of Endocuff or not, method of attempted TI intubation (gas vs. water filling), success rate of intubation, time to intubate in successful cases and depth of intubation. The depth of intubation was estimated by the endoscopist as 1 to 5 cm, 5 to 10 cm, or ≥10 cm. A stop watch was used to record the time to intubate the TI. Only 1 minute was allowed to make the attempt. If the attempt was made under water time was allowed to deflate the cecum, fill it with water, and locate the valve before the 1-minute timer was started. If the attempt failed, the alternative method (gas or water filling) was attempted, with again 1 minute allowed to make the second attempt.

Permission to review this quality control database for patterns of successful TI intubation was granted by the IRB at Indiana University.

Outcome measures

The primary outcome was success of TI intubation with or without Endocuff Vision. The TI was considered intubated if the endoscopist was able to cross the ileocecal valve with the endoscope tip, pass fully into the TI (pass both lips of the valve opening) and stayed there long enough to take a picture. This definition was used because in a number of instances, especially with EV, a view of the TI could be obtained but the colonoscope tip could not pass the actual orifice and fully enter into the ileum. Secondary outcomes were the effect of type of colonoscope (adult vs. pediatric) and water filling on TI intubation.

Statistical analysis

We report procedure characteristics using descriptive measures. The success of TI intubation is reported as a proportion of all procedures and chi-square test or the Fisher exact test was used to test the significance between various groups. Student t-tests were used to compare the time taken for TI intubation. We performed a multivariable analysis using age, gender, type of colonoscope, method of TI intubation, and Endocuff use to predict success of TI intubation or in case of failed cases, rescue of TI intubation. A binary logistic regression model with enter method was used in both cases. We report odds ratios with confidence intervals. All analyses were performed using SPSS Version 26 (IBM, Armonk, NY, USA)

Results:

Patients and procedures

A total of 204 eligible patients underwent colonoscopy during the study period. Women comprised 54% of the study population and average age was 63.1 (±11.2) years. An adult colonoscope was used in 106 (52%) patients. Most patients underwent colonoscopy for a surveillance indication (70%) followed by screening (19%), and then diagnostic and therapeutic indications. The EV group was younger (mean of 62 years vs 67 years, p = 0.006), had a trend towards having more males (50% vs 34%, p = 0.054), and use of the water method for the first attempt at intubation was more common (50% vs 29%, p = 0.009) (Table 1). No significant differences were observed between the gas first and water first groups except that EV use was more common in the water group (82% vs 66%, p=0.009) (other comparisons not shown).

Impact of Endocuff Vision and water method on TI intubation

TI intubation in ≤ 1 minute was less successful with use of EV (91% without EV vs 65% with EV, p < 0.001). For procedures using EV, TI intubation in ≤ 1 minute was more likely with the water method first compared with the gas method first (74% vs 56%, p = 0.019) (Table 2). Logistic regression models indicated that not using Endocuff Vision, water method for terminal ileal intubation and use of a pediatric colonoscope were associated with successful TI intubation in ≤1 minute (Table 3). However, the water method led to a significant increase in TI intubation in ≤1 minute only when adult endoscopes with EV were used (70% vs 46%, p = 0.044) (Table 4). Without EV, there was no difference in TI intubation in ≤1 minute with water filling (94% with water filling vs 90% with gas, p = 1.0).

"Rescue" TI intubation with alternative method

Successful rescue of TI intubation was also more common with water filling, ie, when water filling was used for the rescue attempt after an attempt with gas first failed (58% vs 21%, p = 0.011) (Table 2). Again, however, the water method was statistically more successful as a rescue method after a first failed attempt with gas only when the adult colonoscope with EV was in use (52% vs 10%, p = 0.046) (Table 4). Logistic regression performed on failed cases reveals that only the water method was associated with successful rescue TI intubation in ≤1 minute (Table 5).

Time to intubate and depth of intubation

Mean time to successfully intubate the TI was not different between gas and water methods overall, but was slower with EV use than without (32 seconds vs 19 seconds, p = 0.006). Maximum depth reached into the TI in successful cases also differed with more patients in the without EV arm at an estimated 5 cm or more (78% vs 50%, p = 0.001) (Table 1).

Adult vs. pediatric colonoscopes

The adult and pediatric colonoscopes were not significantly different in success of TI intubation in ≤1 minute without EV in place (91% for each), but using EV pediatric colonoscopes were more successful at TI intubation in ≤1 minute compared with adult colonoscopes (73% vs 57%, p = 0.043) (Table 4).

Discussion:

In this study, we report a prospective nonrandomized assessment of several approaches to intubation of the TI during routine screening and surveillance examinations.

Our results show that use of EV does decrease the success rate of terminal ileal intubation in ≤1 minute, and that this effect is more marked when using adult colonoscopes with Endocuff Vision (EV) in place compared with pediatric colonoscopes. The obvious explanation for this difference would be the difference in the diameter of the distal colonoscope tips and the respective adult and pediatric EV devices. However, from the perspective of routine TI intubation in patients without a clear mandate to intubate the TI, use of EV creates more failures with the adult than the pediatric colonoscope. In addition, when TI intubation is successful, it takes longer with EV in place compared with without the device.

We found that an initial attempt at TI intubation underwater was more likely to lead to successful TI intubation than an initial attempt with gas insufflation, but only in the case where an adult colonoscope with EV was in use. In this study, if the initial attempt at TI intubation was made with gas or water filling of the cecum and right colon segment, and the attempt failed, we tried the alternate approach. Water filling in the second attempt was more likely to lead to success when the first attempt had been with gas, than the opposite situation in which gas was used to make a second attempt after an initial failure with water filling. Thus, taken together, the water filling approach appears more likely to lead to successful TI intubation when an adult colonoscope with EV is in use. Although our results suggest that improvement with water immersion might be limited to adult colonoscopes with EV we can't rule out a type II error, because pediatric colonoscopes with EV were generally more effective in the first attempt, leaving fewer examinations for evaluation of a rescue attempt. Numerically, water was more

successful as a rescue method after a failed first attempt using a pediatric colonoscope with EV (67% vs 33%, Table 3).

Our results suggest that practitioners performing routine colonoscopies who like to routinely intubate the TI, and also like to use EV, will have a greater success rate of TI intubation if they use a pediatric colonoscope. Those preferring an adult colonoscope with EV who like to routinely intubate the TI, might consider the use of an underwater attempt at TI intubation. In our anecdotal experience, the water method has the disadvantage of requiring slightly greater time to deflate the right colon segment and cecum and fill it with water, so that the ileocecal valve assumes the relaxed position. Anecdotally, the process is more efficient when the bowel preparation is excellent in the cecum and ascending colon because initiation of the water filling process in the cecum in a patient with an imperfect prep often requires some degree of water exchange for clear instilled fluid in order to locate the valve orifice.

Strengths of this study include the prospective design, and strict adherence to a 1-minute time maximum to allow achieving TI intubation. This method strengthens the comparison between the intubation and type of colonoscopes. Limitations include the nonrandomized design, though as noted above there is no reason to believe that the endoscopist could predict the anatomy of the cecum and ileocecal valve when patients with inflammatory bowel disease were excluded. The entire study was performed by a single expert endoscopist, which could limit the generalizability of the result. However, the use of a single experienced endoscopist also enhances the comparisons of colonoscopes, devices, and techniques.

In summary, we found that Endocuff Vision does impair terminal ileum intubation during routine colonoscopy. The impact is less when using pediatric colonoscopes with EV compared with adult colonoscopes. When using an adult colonoscope with EV, water filling of the cecum and right colon segment enhances TI intubation and could be used as a primary method of TI intubation or a rescue method when TI intubation with gas insufflation of the cecum and right colon segment fails.

References:

1. Chin M, Karnes W, Jamal MM, et al. Use of the Endocuff during routine colonoscopy examination improves adenoma detection: A meta-analysis. World J Gastroenterol 2016;22:9642-9649.
2. Rex DK, Sagi SV, Kessler WR, et al. A comparison of 2 distal attachment mucosal exposure devices: a noninferiority randomized controlled trial. Gastrointest Endosc 2019;10.1016/j.gie.2019.06.046.
3. Rex DK, Repici A, Gross SA, et al. High-definition colonoscopy versus Endocuff versus EndoRings versus full-spectrum endoscopy for adenoma detection at colonoscopy: a multicenter randomized trial. Gastrointest Endosc 2018;88:335-344 e2.
4. Ngu WS, Bevan R, Tsiamoulos ZP, et al. Improved adenoma detection with Endocuff Vision: the ADENOMA randomised controlled trial. Gut 2019;68:280-288.
5. van Doorn SC, van der Vlugt M, Depla A, et al. Adenoma detection with Endocuff colonoscopy versus conventional colonoscopy: a multicentre randomised controlled trial. Gut 2017;66:438-445.
6. Rex DK, Slaven JE, Garcia J, et al. Endocuff Vision Reduces Inspection Time Without Decreasing Lesion Detection in a Randomized Colonoscopy Trial. Clin Gastroenterol Hepatol 2019;10.1016/j.cgh.2019.01.015.
7. Tsiamoulos ZP, Misra R, Rameshshanker R, et al. Impact of a new distal attachment on colonoscopy performance in an academic screening center. Gastrointest Endosc 2018;87:280-287.
8. Bhattacharyya R, Chedgy F, Kandiah K, et al. Endocuff-assisted vs. standard colonoscopy in the fecal occult blood test-based UK Bowel Cancer Screening Programme (E-cap study): a randomized trial. Endoscopy 2017;49:1043-1050.
9. Triantafyllou K, Gkolfakis P, Tziatzios G, et al. Effect of Endocuff use on colonoscopy outcomes: A systematic review and meta-analysis. World J Gastroenterol 2019;25:1158-1170.
10. Yu AR, Samarasena JB, Alkayali T, et al. Usability of AmplifEYE- and Endocuff Vision-Assisted Colonoscopy Compared to Conventional Colonoscopy During Colonoscopy. American Journal of Gastroenterology 2017;112:S159-S160.

11. Gonzalez-Fernandez C, Garcia-Rangel D, Aguilar-Olivos NE, et al. Higher adenoma detection rate with the endocuff: a randomized trial. Endoscopy 2017;49:1061-1068.
12. Jeong SH, Lee KJ, Kim YB, et al. Diagnostic value of terminal ileum intubation during colonoscopy. J Gastroenterol Hepatol 2008;23:51-5.

Figure legend

Figure 1. Endocuff Vision at the tip of colonoscope; adult device to the left, pediatric device on the right.

Table 1. Demographics and procedure characteristics according to Endocuff Vision use

	Without Endocuff Vision	With Endocuff Vision	*P* value
N	55	149	
Female, n (%)	36 (65.5)	75 (50.3)	0.054
Age, years (SD)	66.7 (10.9)	61.9 (11.1)	0.006
Adult colonoscope, n (%)	34 (61.8)	72 (48.3)	0.087
Gas method tried first, n (%)	39 (70.9)	75 (50.3)	0.009
TI intubation successful on first try, n (%)	50 (90.9)	97 (65.1)	<0.001
Time taken for TI intubation in successful cases on first try, seconds (SD)	19 (16)	32 (19)	0.006
Estimated maximum depth of TI intubation in successful cases on first try >10 cm, n (%) 5-10 cm 1-5 cm	 36 (65.5) 7 (12.7) 7 (12.7)	 56 (37.6) 18 (12.1) 23 (15.4)	0.001
TI intubation success on second try using different method when first attempt failed	4/5 (80)	23/52 (44.2)	0.179†

TI: terminal ileum
† Fisher exact test

Table 2. Demographics and procedure characteristics according to the first method tried to intubate terminal ileum in the Endocuff Vision group (gas vs. water filling)

	Gas method first	Water method first	*P* value
N	75	74	
Female, n (%)	35 (46.7)	40 (54.1)	0.367
Age, years (SD)	61.6 (12.0)	62.1 (10.1)	0.763
Adult colonoscope, n (%)	39 (52.0)	33 (44.6)	0.366
TI intubation successful on first try, n (%)	42 (56.0)	55 (74.3)	0.019
Time taken for TI intubation in successful cases on First try, seconds (SD)	33 (20)	31 (18)	0.602
Estimated maximum depth of TI intubation in successful cases on first try > 10 cm, n (%) 5-10 cm 1-5 cm	 27 (64.3) 6 (14.3) 9 (21.4)	 29 (52.7) 17 (30.9) 9 (16.4)	0.161
TI intubation success on second try using different method when first attempt failed	19/33 (57.6)	4/19 (21.1)	0.011

TI: terminal ileum
SD: standard deviation

Table 3. Multivariable analysis[†] of TI intubation success at first attempt

Factor	OR (95% CI)	*P* value
Age, yearly increment	0.97 (0.94-1.00)	0.085
Gender Female Male	 1 1.30 (0.67-2.55)	0.442
Colonoscope type Adult Pediatric	 1 2.04 (1.03-4.01)	0.040
Endocuff use Yes No	 1 8.86 (3.11-25.29)	<0.001
First method of attempted TI intubation Gas Water	 1 2.26 (1.14-4.48)	0.019

TI, Terminal ileum; OR, Odds ratio

[†]Binary logistic regression using enter method

Table 4. Success of terminal ileum intubation by gas or water filling according to the use of Endocuff Vision and type of colonoscope

	Colonoscope type, n	Success, n (%)	*P* value	First try method, n	Success, n (%)	*P* value	Rescue at 2nd attempt, n (%)	*P* value
Endocuff Vision	Adult, 72	41 (56.9)	0.043	Gas, 39	18 (46.2)	0.044	11 (52.4)	0.046†
				Water, 33	23 (69.7)		1 (10)	
	Pediatric, 77	56 (72.7)		Gas, 36	24 (66.7)	0.263	8 (66.7)	0.198†
				Water, 41	32 (78)		3 (33.3)	
Without Endocuff Vision	Adult, 34	31 (91.2)	1.000†	Gas, 24	21 (87.5)	0.539†	2 (66.7)	
				Water, 10	10 (100)		0	
	Pediatric, 21	19 (90.5)		Gas, 15	14 (93.3)	0.500†	1 (100)	
				Water, 6	5 (83.3)		1 (100)	

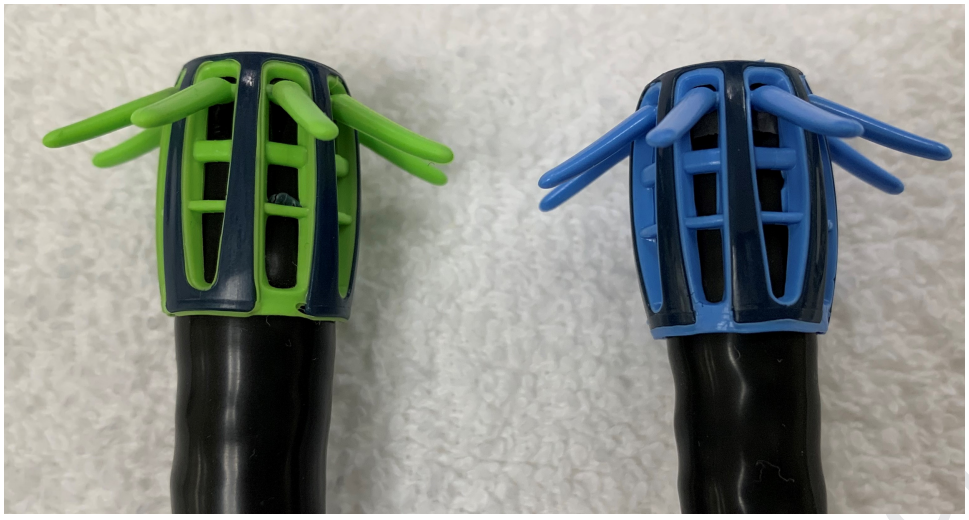
† Fisher exact test

Table 5. Multivariable analysis[†] of TI intubation rescue in the 57 failed cases at first attempt

Factor	OR (95% CI)	*P* value
Age, yearly increment	0.97 (0.90-1.03)	0.288
Gender		0.325
Female	1	
Male	1.84 (0.55-6.19)	
Colonoscope type		0.086
Adult	1	
Pediatric	3.07 (0.85-11.01)	
Endocuff use		0.115
Yes	1	
No	7.33 (0.62-87.31)	
2nd method of attempted TI intubation		0.017
Gas	1	
Water	5.46 (1.36-22.02)	

TI, Terminal ileum; OR, Odds ratio

[†]Binary logistic regression using enter method



Acronyms and abbreviations list

TI – terminal ileum
EV – Endocuff Vision
vs. – versus