

The water method is effective in difficult colonoscopy – it enhances cecal intubation in unsedated patients with a history of abdominal surgery

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Abbreviations: ACC, Ambulatory Care Center; BMI, body mass index; IRB, institution review board; RCT, randomized controlled trial; SD, standard deviation; VAMC, Veterans Affairs Medical Center; VANCHCS, Veterans Affairs Northern California Health Care System; VAGLAHS, Veterans Affairs Greater Los Angeles Healthcare System

Background: Colonoscopy in unsedated patients in the US is considered to be difficult. Success rate of cecal intubation is limited by discomfort. Colonoscopy in patients with a history of abdominal surgery is also considered to be difficult due to adhesion-related bowel angulations. The water method has been shown to significantly reduce pain during colonoscopy.

Objective: To test the hypothesis that the water method enhances the completion of colonoscopy in unsedated patients with a history of abdominal surgery.

Design: The data bases of two parallel RCT were combined and analyzed.

Setting: Two Veterans Affairs endoscopy units.

Patient and Methods: The water and air methods were compared in these two parallel RCT examining unsedated patients. Those with a history of abdominal surgery were selected for evaluation.

Main Outcome Measurements: Completion of unsedated colonoscopy.

Results: Among patients with a history of abdominal surgery, the proportion completing unsedated colonoscopy in the water group (19 of 22) was significantly higher than that (11 of 22) in the air group ($p=0.0217$, Fisher's exact test).

Limitations: Small number of predominantly male veterans, unblinded colonoscopists, not all types of abdominal surgery (e.g. hysterectomy, gastrectomy) predisposing to difficult colonoscopy were represented.

Conclusion: This proof-of-principle assessment confirms that in patients with a history of abdominal surgery the water method significantly increases the proportion able to complete unsedated colonoscopy. The water method deserves to be evaluated in patients with other factors associated with difficult colonoscopy.

Introduction

A recent hypothesis-generating review suggested that the water method may enhance the success of cecal intubation in difficult colonoscopy.¹ The aim of this report is to determine if the water method² enhances colonoscopy outcome in unsedated patients with a history of abdominal surgery. We completed two randomized controlled trials (RCT), one in scheduled, unsedated patients³, and another in patients who accepted on demand sedation⁴. In the subgroup with a history of abdominal surgery, the hypothesis that the water method significantly increases the

proportion of patients able to complete unsedated colonoscopy is evaluated.

Methods

The water method for colonoscopy.

Details of the water method as developed by our research team have been described.² The water method involved warm water infusion in lieu of air insufflation as the principal modality to decrease pain during insertion of the colonoscope. Warm water was infused through the biopsy channel intermittently via a tube fitted with a blunt needle adaptor using a peristaltic pump. Removal of the residual luminal air collapsed the colon around the tip of the colonoscope. Angulations at the flexures were reduced. The tip of the endoscope was directed toward and abutted the "slit-like" lumen ahead. If the orientation was correct, the infused

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water opened the lumen. If the orientation was incorrect, no opening would appear. The colonoscope tip was pulled away from the mucosa and redirected. This translated into a series of to and fro, back and forth, or repeated insertion and withdrawal motions of the shaft of the colonoscope. When the luminal water was turbid due to suspended residual feces, the discolored water was suctioned and replaced by clean water until the colonic lumen was visualized again. The simultaneous suction and infusion created sufficient turbulence near the tip of the colonoscope to pull the residual fecal matter off the surrounding mucosa. Most of the infused water in fact was aspirated into the suction bottle, thereby obviating over-distension. No specific limit was set on the volume [200 ml (clean colon) to 2000 ml (dirty colon)] of water used.

The reason for omission of air insufflation was that air could lengthen the colon, making cecal intubation in the unsedated patient more difficult. Omission of the air was implemented by turning the air pump off before insertion of the colonoscope into the rectum to avoid accidental insufflation of air. Air was not insufflated until the cecum was reached. Minimization of angulations at the sigmoid flexure by suction removal of the residual air in the rectosigmoid has been well-described.^{5,6} Suction removal of all residual colonic air was implemented to minimize angulations at all the flexures (e.g. splenic, hepatic or redundant segments) or at sites of fixation due to post operative adhesions. If advancement of the colonoscope failed, the assistant would provide abdominal compression or the patient's position was changed to facilitate passage of the colonoscope. If the advancement of the colonoscope was uninterrupted, no abdominal pressure or change in patient position was employed. Cecal intubation was suggested by appropriate movement of the endoscopic image on the monitor screen when the right lower quadrant was gently palpated, or ~90 cm of the colonoscope was in the colon in the short configuration, or the appendix orifice was visualized under water. Air insufflation was then used to distend the cecum to confirm visualization of the ileocecal valve and/or the appendix orifice (cecal intubation).

Two RCT were completed to determine if the water method significantly increased the proportion of patients who could complete colonoscopy without sedation when the option of scheduled, unsedated (NCT00747084)³ or on demand sedation (NCT00920751)⁴ was accepted by the veterans. Both RCT were approved by the local Institutional Review Board (IRB) – the VAGLAHS and the VANCHCS. All patients signed written consents to participate in the studies. Patients' demographic variables, history of abdominal surgery, cecal intubation and the maximum discomfort during colonoscopy were recorded in both RCT.

Results

All of the patients (n=44) entered into the analysis had a history of abdominal surgery. These included appendectomy (n=16); cholecystectomy (n=6); repair of abdominal (n=10) or inguinal (n=6) hernia; bladder resection, bladder suspension, Caesarean-section, splenectomy, vagotomy and repair of abdominal aneurysm (n=1 each) (**Table 1**). The proportion completing unsedated colonoscopy in the water group (19 of 22, 86%) was significantly higher than that (11 of 22, 50%) in the air group (p=0.0217,

Fisher's exact test) (**Table 2**). There were no significant differences in age between those examined by the air or the water method, although there was a trend towards younger age in those who did not complete unsedated colonoscopy (**Table 2**). The body mass index (BMI) and time to cecum varied between groups but the differences were not significant, although there was a trend towards lower BMI and shorter time to the cecum in those who did not complete unsedated colonoscopy. By design, the volume of water used was significantly lower in the air group. Those who failed unsedated colonoscopy in the air group had significantly higher mean maximum discomfort score during colonoscopy. Those who failed unsedated colonoscopy in the water group had numerically higher mean maximum discomfort score during colonoscopy, but the difference was not significant.

Discussions

The rationale for combining the results of the two RCT is that the same water method was used in both study and the end point was completion of colonoscopy without sedation in both cohorts. Since unsedated colonoscopy is rare in the US, the combination of outcome data in RCT comparing the water and air method to obtain a sufficiently large sample size to address the proposed hypothesis is justified. The data revealed a significant favorable effect of the water method in these difficult colonoscopy patients. The abdominal operations recorded in this report (**Table 1**) are known to be associated with difficult colonoscopy. They included a history of appendectomy⁷, cholecystectomy⁸ and abdominal^{9,10} or inguinal¹¹ hernia repair. Bladder resection and suspension were examples of pelvic surgery associated with difficult colonoscopy.¹² Caesarean-section, splenectomy, vagotomy and abdominal aneurysm repair could result in adhesions predisposing to difficult colonoscopy.¹⁰

Expert colonoscopists with access to modern endoscopes and accessories rarely failed to achieve cecal intubation even in the difficult patients.¹³⁻¹⁵ In many instances difficult or previously failed colonoscopies were due to angulated sigmoid or redundant colon.¹³ It is noteworthy that in commenting on a recent water method publication¹⁶ one critic concluded that in his experience “water infusion has value in patients with difficult colons from either complex sigmoid or redundancy”¹⁷. Such subtle endorsement lends support to the call¹ for well-designed RCT to render thorough evaluations of the efficacy of the water method in difficult colonoscopy patients.

Failure to achieve cecal intubation due to discomfort in ~20% of patients scheduled for unsedated colonoscopy without sedation backup (due to nursing shortage)¹⁸ led to work on developing a less painful method. Initial investigation showed that cecal intubation could be achieved without the use of air insufflation in patients who received full-dose¹⁹ or half-dose¹⁹ of usual sedation medications. When combined with sedation on-demand, the water method permitted 52%²⁰ to complete colonoscopy without sedation. In consecutive groups examined by the air and water methods, the latter was associated with less pain, higher cecal intubation rate and greater willingness to repeat unsedated colonoscopy.²¹ In difficult-to-sedate patients (narcotic pain medication usage or demonstrated paradoxical agitation), the water method facilitated

Table 1. Previous abdominal surgery and outcome with the air or water method

Completed unsedated	Air (n=22)		Water (n=22)		n
	Yes	No	Yes	No	
Appendectomy	2	4	8	2	16
Cholecystectomy	4	2			6
Abdominal hernia	5	1	4		10
Inguinal hernia		2	4		6
Bladder resection		1			1
Bladder suspension			1		1
Caesarean-section				1	1
Splenectomy			1		1
Vagotomy		1			1
Abdominal aneurysm			1		1

Table 2. Patient- and procedure-related outcomes

Method	Air (n=22)		Water (n=22)		p
Completed unsedated	Yes	No	Yes	No	
Number	11 (50%)	11 (50%)	19 (86%)	3 (14%)	0.0217 ^a
Age (yrs)	64.5 (8.9)	58.0 (9.0)	63.0 (9.1)	57.0 (4.6)	0.2422 ^b
BMI	35.4 (8.9)	30.1 (6.8)	30.1 (5.3)	27 (6.6)	0.1205 ^b
Time to cecum (min)	22.8 (16.4)	18.4 (15.1)	21 (12.4)	11.3 (3.2)	0.6070 ^b
Volume of water (ml)	127 (163)	13 (29)	1424 (719) ^{c,d}	1067 (551) ^{c,d}	0.0001 ^b
Maximum discomfort	3.7 (2.1)	5.5 (1.8) ^c	2.5 (2.0) ^d	4.0 (1.0)	0.0032 ^b

Data are means (SD). Maximum discomfort (0=none, 10=most severe).

^aFisher's exact test; ^bANOVA with contrasts, ^cvs. air & yes, ^dvs air & no.

completion of unsedated colonoscopy.²² In three unsedated patients who failed a previous unsedated colonoscopy using the usual air method, the water method provided salvage cecal intubation.³ In RCT comparing air vs. water method we found that the latter significantly increased the proportion of patients completing unsedated colonoscopy (3,4), minimized discomfort in the unsedated³, and reduced the dosage of medications needed by the sedated^{6,16} patients. The current analysis has revealed that a significantly higher proportion of patients examined by the water method achieved cecal intubation without sedation in spite of their history of abdominal surgery.

Others reported that in patients with difficult colonoscopy due to lower gastrointestinal bleeding^{23,24}, including those with sigmoid resection and immediate post-operative hemorrhage²⁵, the source of bleeding could be diagnosed more readily when the colonic lumen was filled with water. The use of water as an adjunct to air insufflation described almost three decades ago facilitated passage through segments of severe diverticulosis.²⁶ More recently infusion of warm water as an adjunct to air insufflation was described for managing colonic spasms²⁷, a potential contributor to making a colonoscopy difficult. Taken together these observations suggest that the water method may have a role in facilitating the examination of difficult colonoscopy patients in general.

Difficult colonoscopy has its associated patient, prior history and current colonoscopy characteristics. Patient characteristics included female gender^{12,28,29}, low body mass index (BMI) (≤ 25)^{7,12}, female gender with low BMI^{30,31}, younger age (≤ 40 or ≤ 20 years)¹², advanced age (>50 years)³⁰, older age (>80 years)⁷, anxiety and anticipated discomfort²⁹. Characteristics pertaining

to past history included abdominal and/or pelvic surgery^{8,12,30,31}, diagnosed left-sided diverticulosis³¹, incomplete colonoscopy (due to redundant colon, difficult sigmoid or difficult sedation)³², unsatisfactory (poor) bowel preparation³³ and irritable bowel syndrome³¹. Characteristics associated with current colonoscopy included difficult anatomy²⁸, patient pain or discomfort^{28,30}, symptoms of inflammatory bowel diseases¹², prolonged insertion time (>480 sec), technically difficult insertion¹², lower gastrointestinal bleeding²⁴, obstructing malignancy²⁸, severe inflammation²⁸, poor bowel preparation^{12,28,30}, failure to reach the cecum^{34,35}, unsedated colonoscopy^{3,18,21,22,36} and colonoscopy following gastroscopy³¹. Methods reported to minimize patient discomfort or enhance cecal intubation during colonoscopy were reviewed³⁷ and included the use of pediatric colonoscope, variable stiffness colonoscope, gastroscope, computer assisted colonoscope, magnetic endoscope imaging, hypnosis, patient inhalation of nitrous oxide, listening to music, distraction by audio stimuli, or simply allowing the patients to participate in administration of the sedation medication. Endoscopist-controlled (as needed sedation), patient-controlled (on demand sedation), or extended flexible sigmoidoscopy were additional approaches discussed.³⁷ Four papers reviewed by Leung in 2008³⁷ and two recent studies^{31,38} reported that carbon dioxide insufflation reduced pain “after” but “not during” colonoscopy. Only one report described a reduction of pain after as well as during colonoscopy.³⁹ Thus, six of the 7 trials did not support carbon dioxide-induced reduction of pain during colonoscopy. Furthermore, intent-to-treat analysis was not used in the report by Wong et al.³⁹ Failed cecal intubation, excessive looping accounted for the exclusion from analysis of 2 patients

in the carbon dioxide group. These two likely had high pain scores. If they were not excluded the difference from the control group might not have been significant. Advances in technology such as double-balloon¹⁴ and single balloon^{34,40} endoscopes have been reported to salvage cecal intubation in those who failed by conventional colonoscopy^{34,40} or simply in enhancing cecal intubation³⁴, respectively. Propofol sedation has been endorsed by one expert on “difficult colonoscopy”³², but the involvement of an anesthesiologist to oversee propofol administration increases costs. Attention to techniques has been recommended³², but acceptance of the recommendation requires admission of suboptimal prior training and practice. Repeat bowel preparation and next day colonoscopy³³ has been proposed as a suitable approach to deal with those with failed cecal intubation due to poor bowel preparation, and naturally incurs another bowel purge and an additional visit. The transparent hood attached to the tip of the colonoscope reduced pain and enhanced cecal intubation was reviewed³⁷ but there was one subsequent report with conflicting data³⁵. Use of a non standard small caliber overtube-assisted colonoscopy⁴¹ has also been recommended. A head-to-head comparison of the water method with each of the above modalities in the difficult colonoscopy patients will be instructive.

The cecal intubation rate of 50% in the unsedated patients examined by the air method in the current study compares favorably with the result of a recent report on unsedated colonoscopy in a community-based endoscopy unit in the US.⁴² Patients with prior abdominal surgery were less likely to complete the examination without sedation (44% vs. 61%).⁴² Our finding that the water method enhanced the cecal intubation rate to 86% (Table 2) in the unsedated patients with a history of abdominal surgery in the current report is clearly superior and provocative.

The current report has important limitations. The majority of the patients were male veterans. Whether the observations will be applicable to non veteran patients is not known and deserves to be further studied.⁴³ There were no patients with a history of gastrectomy⁸ or hysterectomy⁸, two abdominal surgical conditions linked in a significant way to incomplete colonoscopy. The current results are based on analysis of the combined outcome data of two parallel RCT. Nonetheless, the current results and the hypothesis-generating data discussed in a recent review¹ are sufficiently provocative to warrant calling for prospective, RCT to thoroughly evaluate the impact of the water method on colonoscopy performance in the patients with a history of abdominal surgery or other factors associated with difficult colonoscopy. A more intriguing series of evaluations is the comparison of the water method with each of the advanced modalities reported to be efficacious for difficult colonoscopy. In pragmatic terms the use of the water method in patients with factors [unsedated]⁴⁴ and (complex sigmoid or redundancy)¹⁷ associated with difficult colonoscopy did receive recent critical but favorable editorial endorsement in the US^{17,44}.

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