Retrospective analysis showing the water method increased adenoma detection rate – a hypothesis generating observation

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Abbreviations: CPRS, computerized patient record system; NBI, narrow band imaging; RCT, randomized controlled trial; SD, standard deviation; VAMC, Veterans Affairs Medical Center

Background: A water method developed to attenuate discomfort during colonoscopy enhanced cecal intubation in unsedated patients. Serendipitously a numerically increased adenoma detection rate (ADR) was noted.

Objective: To explore databases of sedated patients examined by the air and water methods to identify hypothesis-generating findings. **Design:** Retrospective analysis. **Setting:** VA endoscopy center. **Patients:** Screening colonoscopy.

Interventions: From 1/2000-6/2006 the air method was used - judicious air insufflation to permit visualization of the lumen to aid colonoscope insertion and water spray for washing mucosal surfaces. From 6/2006-11/2009 the water method was adopted - warm water infusion in lieu of air insufflation and suction removal of residual air to aid colonoscope insertion. During colonoscopy withdrawal adequate air was insufflated to distend the colonic lumen for inspection, biopsy and polypectomy in a similar fashion in both periods. **Main outcome measurements:** ADR.

Results: The air (n=683) vs. water (n=495) method comparisons revealed significant differences in overall ADR 26.8% (183 of 683) vs. 34.9% (173 of 495) and ADR of adenomas >9 mm, 7.2% vs. 13.7%, respectively (both P<0.05, Fisher's exact test). **Limitations:** Non-randomized data susceptible to bias by unmeasured parameters unrelated to the methods.

Conclusion: Confirmation of the serendipitous observation of an impact of the water method on ADR provides impetus to call for randomized controlled trials to test hypotheses related to the water method as an approach to improving adenoma detection. Because of recent concerns over missed lesions during colonoscopy, the provocative hypothesis-generating observations warrant presentation.

Introduction

In about 20% of veterans undergoing scheduled unsedated colonoscopy discomfort precluded cecal intubation.¹ These uncomfortable examinations using conventional air colonoscopy led to a search for methods to minimize such discomfort² and the subsequent development of a novel method to aid colonoscope insertion.^{3,4} The method involved warm water infusion in lieu of air insufflation coupled with suction removal of all residual air in the colon (water method).^{3,4} In a consecutive group observational study, in addition to enhancing cecal intubation, the water method resulted in a numerically higher proportion of patients with at least one adenoma - adenoma detection rate (ADR),⁵ possibly by improving colon cleanliness. With an open-minded approach coupled with healthy skepticism that the water method

could not have made such an unexpected impact, these observations prompted a review of a larger sample of sedated veterans examined by the air (n=683) and water (n=495) methods. The aim was to secure hypothesis-generating observations to determine what type of follow up RCT might be warranted.

Methods

This is a retrospective review of prospectively collected data in a colonoscopy database (GI Trac, Akron Systems) at the Sacramento VAMC. Data-mining aimed to identify patients who underwent screening colonoscopy performed by a colonoscopist with expertise in both the air and water methods. All patients received standard instructions for bowel preparation, a low-residue diet for 2 days before and 2 tablets of bisacodyl plus 1 gallon of Colyte (polyethylene glycol-electrolyte) on the day before the procedure.^{4,6,7} All cases were performed in the morning (8 AM to 12 noon). From 1/2000-6/2006, the air method was used. Judicious air insufflation permitted visualization of the lumen for insertion of the colonoscope; syringe-delivered water was used in

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the usual manner for washing mucosal surfaces for inspection. From 6/2006-6/2009, the water method⁴⁻⁸ was adopted. Warm water infusion in lieu of air insufflation and suction removal of residual air were used to aid insertion. During colonoscopy withdrawal in both methods air was insufflated to adequately distend the lumen to facilitate mucosal inspection, biopsy or polypectomy. Optimal techniques⁹ including interrogating the proximal sides of folds, flexures, and valves, clearing fluid and debris, and distending adequately were employed consistently during both periods. Size measurement was performed using opened forceps. All removed lesions were submitted for pathological evaluations.

Demographic data were collected by cross reference with the VA Computerized Patient Record System (CPRS). Approval was granted by the local Institutional Review Board (IRB) to review and report the data. Waiver of informed consent was granted by the IRB because the collected data were de-identified from patients' personal information.

The water method for colonoscopy "Water-related techniques" reviewed by Leung³ emphasized their use as "adjuncts to air insufflation". Salient features and nuances of implementation of the water method⁴⁻⁸ are as follows. The water method⁴⁻⁸ involved warm water infusion in lieu of air insufflation as the "principal modality" to decrease the discomfort of colonoscopy insertion. The reason for omission of air insufflation was that air could lengthen the colon and exaggerate angulations at the flexures,³⁻⁵ making insertion in the unsedated patient more difficult. This was implemented by turning the air pump off before insertion of the colonoscopy into the rectum to avoid accidental insufflation of air. Air was not insufflated until the cecum was reached.⁴⁻⁸ Residual air was removed by pointing the tip of the colonoscopy into the air pocket and applying suction. Minimization of angulations at the sigmoid flexure by suction removal of residual air was well-explained by Mizukami et al.¹⁰ Water (37°C maintained by a water bath) was infused using a peristaltic pump via a tube fitted with a blunt needle adaptor through the biopsy channel. Residual air in the colon was removed to collapse the colon around the colonoscopy; angulations at the flexures were reduced. The tip of the colonoscopy was oriented towards the slit-like lumen. If the orientation was correct, the infused water opened the lumen ahead. If the orientation was incorrect, no opening would appear, and water infusion was stopped. The colonoscopy tip was pulled back away from the mucosa and redirected. This translated into repeated insertion and withdrawal motions of the shaft of the colonoscopy with a torque in the direction of the expected lumen. 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. If the mucosa was repeatedly stuck to the tip of the suction port, the water pump was triggered just before each application of suction. The simultaneous infusion and suction created sufficient turbulence to dislodge the residual fecal matter from the surrounding mucosa. Most of the infused water in fact was aspirated into the suction bottle instead of remaining in the colon, thereby obviating over-distension. No specific limit was set on the volume of water used. Depending on the amount of residual feces a range of volumes [200 ml (clean colon) to 2000 ml (dirty colon)] were

necessary to ensure adequate visualization during the insertion phase. Appropriate execution of the water exchange to clear the view for further insertion unequivocally reduced the amount of residual fecal matter encountered during the withdrawal phase. If advancement failed, the assistant would provide abdominal compression or the patient changed position to facilitate passage of the colonoscopy. If the advancement 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 palpated, or ~90 cm of the colonoscopy was in the colon in the short configuration, or the appendix orifice (appearing as concentric circular or slit like structures) was visualized under water. Air insufflation was then used to distend the cecum to confirm visualization of the ileocecal valve and the appendix orifice (cecal intubation).

Results

Table 1 summarizes the demographic data of the two screening cohorts. There was no significant difference in the mean age or body mass index (BMI) between the patients examined with the air or water method. The subjects were predominantly male because of the veteran population. None of the patients had a history of familial polyposis syndrome. Nearly 40% of the subjects did not include their ethnicity information in the VA CPRS. There were no reliable entries of the patients' smoking history.

Table 2 shows that at least one adenoma of any size was detected in 26.8% of cases in the air group; and in 34.9% of cases in the water group. The proportion of patients with adenomas >9 mm in size were 7.2% (air) and 13.7% (water). The air vs. water comparisons were statistically significant ($p < 0.05$, Fisher's exact test). The significant differences for the >9 mm adenomas were observed proximal (2.9% vs. 5.9%) and distal (4.2% vs. 7.9%) to the splenic flexure.

Table 3 shows that three of the adenomas that harbored dysplasia or adenocarcinoma were <9 mm in size. All were located proximal to the splenic flexure.

Discussions

Reports in recent literature on the impact of various interventions on polyp detection and ADR have been mostly conflicting. They included discussions on withdrawal time of < vs. >6 min,¹¹⁻¹³ search for adenomas during insertion or withdrawal,¹⁴ morning vs. afternoon colonoscopy,¹⁵⁻¹⁹ single or split-dose bowel preparations,^{18,20-23} standard vs. high definition equipment²⁴⁻²⁸ or standard vs. narrow band imaging colonoscopy.^{29,30} The current review was prompted by a serendipitous observation of an unintended increase in ADR associated with conventional endoscopes and a method developed to minimize discomfort in the unsedated patients.⁵ Since the water method was refined also at the Sacramento VAMC in the sedated patients^{4,6,7}, we surmised that a review of these patients might provide hypothesis-generating information to guide future research. This data-mining exer-

Table 1. Demographic variables, patients with adenomas

Patient Characteristics	Air – with adenomas	Water – with adenomas
Number	183	173
Age, mean (SD)	62.8 (8.2)	62.5 (7.4)
Male	180 (98%)	170 (98%)
Female	3 (2%)	3 (2%)
White	82 (45%)	97 (56%)
Black	14 (8%)	14 (8%)
Latino	2 (1%)	4 (2%)
Asian	2 (1%)	1 (0.5%)
Other	1 (0.5%)	1 (0.5%)
Unknown	82 (45%)	56 (33%)
BMI, mean (SD)	29.6 (4.9)	29.9 (5.6)

BMI, body mass index.

Table 2. Adenoma detection on screening colonoscopy using air and water method

	Air Method	Water Method	p*
Total number of patients	683	495	
Number of patients with at least 1 adenoma	183 (26.8%)	173 (34.9%)	0.0031
Adenoma >9 mm	49 (7.2%)	68 (13.7%)	0.0002
Adenoma >9 mm (proximal)	20 (2.9%)	29 (5.9%)	0.0173
Adenoma >9 mm (distal)	29 (4.2%)	39 (7.9%)	0.0109
Dysplasia/adenocarcinoma	6 (0.88%)	4 (0.81%)	NS

*vs. air, P<0.05; Fisher's exact test. NS, not significant.

Table 3. Size and location of the adenomas with dysplasia or adenocarcinoma

Method	Dysplasia		Adenocarcinoma
	Low Grade	High Grade	
Air	5 mm, 30 mm in ascending 8 mm in transverse	6 mm in cecum 25 mm in sigmoid 30 mm in rectum	20 mm in rectum
Water		20 mm in sigmoid	30 mm in ascending 20 mm in descending 40 mm in rectum

cise did not reinforce the initial skepticism that the increase in ADR by the water method⁵ was a spurious observation.

To put the current results into perspective, the ADR of 26.8% in the air group was of the same order of magnitude as others without trainee involvement, 23%;³¹ in male non veterans 24.4%;³² in patients in Canada 25.5%;³³ or in Israel 26%;³⁴ with high definition colonoscopes, 24.7%,²⁶ 28.8%;²⁸ with narrow band imaging, 23%;³⁰ withdrawal time >6 min, 28.3%;¹¹ or morning colonoscopies, 29.3%.¹⁶ The significantly higher ADR of 34.9% in the water group represented enhanced detection. This was lower than the 37% reported in the VA cooperative study 380.³⁵ The analysis in the current report was focused on the first screening examination. The VA cooperative study 380

included repeat colonoscopies in patients with incomplete initial examinations due to any reason and even operative findings in constructing the ADR. The water group ADR matched the result of one report utilizing chromoendoscopy 33.6%.²¹ Others reported higher ADR of 51%²⁹ with chromoendoscopy and high definition colonoscope or 55.5%²⁷ with narrow band imaging. When only high definition white light colonoscopy was used ADR showed a wide range of variation from 41% to 57%.²⁷ The 13.7% of >9 mm adenoma in the current study was comparable to the 10.2%³⁶ or 18.7%³⁷ of >9 mm or advanced adenomas previously reported. These comparisons strengthen the credibility of the data in both the air and water groups. Colonoscopists with high ADR^{27,29,35,37} are unlikely to need to use the water method.

Evaluation of the impact of this relatively simple, inexpensive, easy-to-learn approach on ADR by others, however, will be instructive.

The water method was developed for a specific patient-centered reason not immediately related to a search for more adenomas.⁵ We speculate that the strict adherence to the steps described above also optimized the soaking effect of water on feces adherent to mucosal surfaces in a collapsed airless colon. Residual stool suspended in the luminal water by the simultaneous suction and infusion was readily removed. Colonoscopists whose patients present consistently with excellent bowel preparation¹⁶⁻²³ will not need to use the water method. Those with patients who present consistently with suboptimal bowel preparation despite efforts to improve bowel cleanliness by adjusting type and schedule of purgatives may consider evaluating the water method. The water method provides what amounts to a colonoscopist-controlled approach to salvage bowel cleansing in those with suboptimal bowel preparation. The extent to which the cleansing contributed to increasing adenoma detection was nonetheless uncertain. There was no *a priori* reason to expect in those patients who did not have adenomas that a cleaner colon would necessarily reveal adenomas during inspection. On the other hand, adenomas which might be obscured by residual feces in a patient with suboptimal bowel preparation would be more likely to be identified after removal of residual feces by the water method. The intuitively obvious association might explain the recent plethora of reports funded by bowel purgative manufacturers to modify the schedule of bowel preparation. To the colonoscopist the approach emphasizing optimal schedule is attractive as it puts the responsibility to provide satisfactory cleanliness entirely on the patients; missed lesions due to suboptimal bowel cleanliness would not be the consequence of ineffective colonoscopy techniques. The current data suggest an alternative in addition to washing of the mucosa during withdrawal to remedy suboptimal bowel preparation. A RCT is warranted to confirm or refute the hypothesis that the water method produces a higher ADR than the air method in the context of the most acceptable bowel preparation schedule. When a single colonoscopist performed the colonoscopy, it was not possible to blind the endoscopist. As in the case of tandem colonoscopy, it may be necessary to have two colonoscopists to properly blind the one responsible for the withdrawal phase.

The recent interest in missed lesions³⁸ has provided the justification for bringing the current hypothesis-generating observations to the attention of readers who may be stimulated to evaluate the hypothesis that the water method can contribute to minimizing missed lesions by increasing ADR. There was indirect evidence to suggest bowel preparation quality affected ADR. Afternoon procedures were prone to be incomplete due to poor bowel preparation.^{15,16} The ADR was significantly higher in the morning compared with the afternoon group (29.3% vs. 25.3%, $p=0.008$).¹⁶ Several studies reported split-dose provided better cleanliness^{21,39-42} without addressing the impact on ADR.^{21,39-42} Same day bowel preparation yielded superior^{19,20} or equivalent¹⁸ bowel cleanliness compared with split-dose. With the exception of one report showing split-dose significantly enhanced detection of flat lesions,²⁰ there was no peer-reviewed report confirming a higher ADR in

patients prepared with the split-dosing or other approaches. RCT using lubiprostone or placebo pretreatment prior to split-dose bowel purge resulted in significantly enhanced colon cleanliness ($p=0.001$) in the experimental group, but did not alter polyp yield 51% (lubiprostone) vs. 47% (placebo).²² In 633 screening colonoscopies, the mean (SD) Boston Bowel Preparation Score (BBPS) score was 6.0 ± 1.6 . Higher BBPS scores ≥ 5 vs. <5 were associated with a higher polyp detection rate (40% vs. 24%, $P<0.02$).²³ One study showing split-dose preparation producing superior cleanliness scores also reported significantly higher polyp detection in those rated as fair/good (27.3%) or good/excellent (24.6%) compared with those rated as poor/fair (12.2%).⁴³ None of these studies,^{22,23,43} however, addressed the impact on ADR.

The water method might have provided the circumstance conducive to salvage cleansing of the colon by the colonoscopist⁵ during colonoscope insertion. During withdrawal the colonoscopist's undivided attention can be focused on inspection instead of distracted by the need to clean stool covered mucosa immediately before inspection. We also speculate that use of warm water might have the effect of minimizing colonic spasm⁴⁴ rendering the colon amenable to a more thorough examination.

The limitations include the retrospective nature of the analysis, unblinded colonoscopist, and cleanliness of the colons was not systematically characterized. Incomplete information in the databases on ethnicity, smoking history or withdrawal time left open the possibility that differences in these and other unmeasured parameters might be responsible for the higher ADR in the water group. Standard resolution equipment was used during both the air and water periods. There was a change to high resolution colonoscopy (without change of standard resolution monitors) in 2008. There are no literature data to indicate that such changes would significantly alter ADR. The use of historic control data may place the data at risk of other unrecognized bias. The data do not reveal whether the water method is superior or inferior to an approach which employs tissue sampling also during insertion.¹⁴ Developed for the specific need to minimize discomfort and enhance cecal intubation in the scheduled, unsedated patients, the water method appeared to have an unintended and provocative effect in increasing ADR. Investigators intrigued by the above hypothesis-generating results are encouraged to support the development of well-designed randomized controlled trials to critically evaluate the hypothesis that strict adherence to the above description of the water method will lead to a significantly higher ADR in screening colonoscopy.

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Disclosure

The authors have no conflict of interests to disclose relevant to this study.

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