

The water exchange method for colonoscopy—effect of coaching

Leung FW^{1,2}, Cheung R³, Fan RS⁴, Fischer LS⁵, Friedland S³, Ho SB⁶, Hsieh YH^{7,8}, Hung I⁹, Li MK¹⁰, Matsui S³, Mcquaid KR¹¹, Ohning G¹², Ojuri A⁴, Sato T³, Shergill AK¹¹, Shoham MA⁵, Simons TC⁴, Walter MH¹³, Yen A¹⁴

¹Gastroenterology, Sepulveda ACC, VAGLAHS, North Hills, CA, United States; ²Medicine, David Geffen School of Medicine at UCLA, Los Angeles, CA, United States; ³VA Palo Alto Healthcare System, Palo Alto, CA, United States; ⁴West Gastroenterology Medical Group, Los Angeles, CA, United States; ⁵Gastrointestinal Medicine Associates, PC, Fairfax, VA, United States; ⁶VA San Diego Healthcare System, La Jolla, CA, United States; ⁷Gastroenterology; Medicine; Buddhist Dalin Tzu Chi General Hospital; Chia-Yi, Taiwan; ⁸School of Medicine; Buddhist Tzu Chi University; Hwalien, Taiwan; ⁹University of Hong Kong, Hong Kong, SAR, China; ¹⁰Tuen Mun Hospital, Hong Kong, SAR, China; ¹¹San Francisco VAMC, San Francisco, CA, United States; ¹²West Los Angeles VAMC, Los Angeles, CA, United States; ¹³Loma Linda University Medical Center, Loma Linda, CA, United States; ¹⁴Sacramento VAMC, VANCHCS, Mather, CA, United States

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Abbreviations: ADR, adenoma detection rate; PEG, polyethylene glycol; RCT, randomized controlled trial; SEM, standard error of mean; SSN, social security number

Abstract

The growing popularity of water immersion is supported by its long history as an adjunct to air insufflation; after facilitating colonoscope passage, the infused water is conveniently removed during withdrawal. Water exchange, a modification of water immersion to minimize discomfort in scheduled unsedated patients in the U.S. is new. Even though it may be superior in reducing pain and increasing adenoma detection, the paradigm shift to complete exclusion of air during insertion necessitates removal of infused water containing residual feces, a step often perceived as laborious and time-consuming. The nuances are the efficient steps to remove infused water predominantly during insertion to maintain minimal distension and deliver salvage cleansing. Mastery of the novel maneuvers with practice returns insertion time towards baseline. In this observational study the impact of direct verbal coaching on the primary outcome of intention-to-treat cecal intubation was assessed. The results showed that 14 of 19 (74%) experienced colonoscopists achieved 100% intention-to-treat cecal intubation. Initiation of the examination with water exchange did not preclude completion when conversion to the more familiar air insufflation method was deemed necessary to achieve cecal intubation (total 98%). The overall intention-to-treat cecal intubation rate was 88%, 90% in male and 87% in female. Only 2.7% of bowel preparation was rated as poor during withdrawal. The mean volume of water infused and cecal intubation time was 1558 ml and 18 min, respectively. Direct coaching appears to facilitate understanding of the nuances of the water exchange method. Studies of individual learning curves are necessary.

Introduction

Water-aided methods for minimizing colonoscopy discomfort are distinguished by the timing of removal of the infused water.¹⁻³ With water immersion, an established adjunct to air insufflation since at least 1984,⁴ infused water is conveniently removed predominantly during withdrawal.⁵⁻¹⁸ With water exchange, a novel approach without use of air insufflation, infused water is removed predominantly during insertion. Recent reviews of randomized controlled trials (RCT) comparing air insufflation with water immersion or water exchange^{1,2} generated provocative discussions.³ Both water immersion and water exchange produce significantly less discomfort during colonoscopy compared with air insufflation; water exchange may be superior to water immersion in minimizing colonoscopy discomfort^{1,3,19} and in

increasing adenoma detection rate (ADR).^{2,3,19} Water immersion as an adjunct to air insufflation is relatively easy to apply. On the other hand, water exchange with the paradigm shift to complete exclusion of air during insertion entails a new set of maneuvers.^{3,20-23} In this observational study we discuss the result of direct coaching of a group of experienced colonoscopists in the water exchange method. We test the hypothesis that complete insertion to the cecum with water exchange guided by a knowledgeable trainer is achievable.

Method

Experienced overseas and U.S. colonoscopists interested in understanding the practice of water exchange were recruited (April 2011 to December 2011). At their respective practice sites they inserted the colonoscope in the presence of the trainer. The experienced colonoscopists had the discretion to convert to usual (more familiar) air insufflation if there was insertion difficulty. The primary outcome was water exchange method intention-to-treat cecal intubation. The trainer provided continuous verbal

*Correspondence to: Felix W. Leung; Email: felix.leung@va.gov
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instructions to aspirate all residual air from the colonic lumen, abut the tip of colonoscope against the slit-like lumen ahead, infuse water to confirm location of the lumen for advancement, suction infused water to clear the view and maintain minimal distension of the colonic lumen, and recognize the appendix opening, ileocecal valve or red suction marks in the cecum.^{3,20-23} A data sheet was used to keep track of demographic and procedure-related variables during the examination.

Results

Patient demographic and procedure-related variables are shown in **table 1**. Highlights of the results showed that 14 of 19 (74%) colonoscopists achieved 100% intention-to-treat cecal intubation with the water exchange method. The overall intention-to-treat cecal intubation rate was 88%, 90% in male and 87% in female patients. The proportion of patients completing without sedation was 8%. The proportion of patients with rating of poor bowel preparation on withdrawal was 2.7%. The mean (SD) volume of water infused was 1558 (1000) ml. The mean (SD) cecal intubation time was 18 (9) min. The total cecal intubation rate was 98%, inclusive of those completing after converting to the more familiar air insufflation method (10%).

Discussion

Air insufflation as the principal modality to aid insertion has been practiced since the invention of the flexible colonoscope. When discomfort limited cecal intubation, sedation was introduced in the U.S. and elsewhere to facilitate insertion. Abdominal compression, patient position change and loop reduction have been

recommended for a long time to enhance success of cecal intubation.²⁴ Water immersion as an adjunct to air insufflation was first described in the U. S. by Falchuk et al.⁴ Subsequent variations⁵⁻⁸ were summarized in a recent review.²⁵ The strength of water immersion rests with the ability to enhance navigation through difficult diverticular segments,⁴ speed arrival to the splenic flexure⁵ or cecum⁷ and to minimize insertion discomfort.^{6,7} Water immersion is relatively easy to apply as the colonoscopist retains the discretion to employ the more familiar modality of air insufflation throughout the examination. When water immersion was used in RCT authors either did not report the need for training^{6-8,11,13,16,17} or described practice in 30¹² to 40¹⁸ cases prior to the start of randomization.

Cecal intubation failure due to pain in scheduled unsedated colonoscopy without back up sedation at one Veterans Affairs site in the U.S.²⁶⁻²⁸ gave rise to the observation that insufflated air was the culprit precipitating failure due to insertion pain. To overcome the avoidable colonic elongation produced by insufflated air the fundamental research question was whether cecal intubation could be achieved without any air insufflation.²⁹ Water immersion was identified as a promising method²⁵ for modification to develop the needed novel approach. The air pump was turned off to obviate inadvertent air insufflation.^{30,31} Suction removal of residual air was initially employed in the rectal sigmoid location,³² and later extended to all air pockets to minimize angulations at the flexures and redundant segments.²¹

Proponents of the water exchange method performed observational studies in^{32,43,44} and 63 veterans who received full,³¹ half dose,³¹ on demand³⁰ or no²⁰ sedation, respectively, to perfect the water exchange maneuvers before embarking on comparisons

Table 1 Demographic variables, primary outcome and secondary outcomes

Demographic variables	
Number of experienced colonoscopists	5 overseas, 14 United States (in 2011)
Number of patients examined	75
Number of cases per colonoscopist (range)	1 to 11
Age of patients (years)	57 (10)
Indications	Screening 37; other 38
Primary outcome	
Intention-to-treat cecal intubation rate	66 of 75 (88%)
Intention-to-treat cecal intubation rate in males	46 of 51 (90%)
Intention-to-treat cecal intubation rate in females	20 of 24 (87%)
Range of Intention-to-treat cecal intubation rate (N=number of colonoscopists, n = number of coached cases)	0% (N=2, n=1 each) 50% (N=1, n=4) 70% (N=1, n=10) 82% (N=1, n=11) 100% (N=14, n=range 1 to 11 cases)
Secondary outcomes	
Overall cecal intubation rate	98%
Cecal intubation time (min)	18 (9)
Number with poor prep during withdrawal	2 (2.7%)
Number requiring abdominal compression	19 (25%)
Number requiring position change	12 (16%)
Proportion completing without sedation	6 (8%)
Volume of water used (ml)	1558 (1100)

Data are expressed as frequency count, percent of total, and mean (SD)

using RCT.³³⁻³⁵ The earliest description of the method identified as "water in lieu of air" to emphasize the absence of air insufflation, however, appeared to have fallen short of fully conveying the nuances of the novel approach of water exchange. Several well-meaning concerns were expressed by colonoscopists who had not experienced the water exchange maneuvers.³ For example, technical details including suction removal of the dirty water and replacement with clean water were deemed too time-consuming when there was production pressure.¹⁸ Poor visualization due to suspended residual feces in the luminal water elicited the response of rescue by air insufflation^{12,18} instead of water exchange to remove debris. Other experienced colonoscopists reported that infusion of a limited volume of water during insertion followed by removal during withdrawal was adequate in reducing discomfort,^{8,11,16} obviating any need for further modification of water immersion. Indirect coaching (e-mail and telephone discussions of methodological references) coupled with self-monitored training followed by optimal attainment of cecal intubation after 50-100 cases³⁶ led one experienced colonoscopist to observe that the water exchange method was "relatively" easy to learn but did require practice.³⁶ The observational study revealed that mastery of the method resulted in cecal intubation rates and overall ADR meeting quality performance standards in sedated veterans.³⁶ A follow up RCT demonstrated a significant increase in ADR, particularly in the proximal colon, compared with air insufflation.³⁷

The current report describes the process and outcome of direct coaching of experienced colonoscopists in the nuances of the novel approach by a proponent of the water exchange method. The process appeared to expedite the transfer of the necessary skills relatively effectively (in only a few cases each) with successful intention-to-treat cecal intubation in the majority of the training sessions. As previously reported³⁶ practice insertion using the novel approach did not preclude completion with air insufflations.

One limitation of the current observational study was that the clinical schedules of the trainer and participants precluded comparable number of cases performed by each experienced colonoscopist. Direct coaching is also time-consuming for the trainer. Since all the participants had to manage a totally new set of maneuvers, it was not surprising that the documented insertion times were longer than their usual insertion times with air insufflation. Anecdotally, participating colonoscopists also described departure from established maneuvers of air insufflation as challenging. Further studies documenting the learning curve of the water exchange method in individual colonoscopist will be instructive. The direct communication of the nuances of the water exchange method lessens the possibility of misinterpretation of the novel approach as just another version of "water immersion" to augment air insufflation. Such an interpretation may account for the discrepancies in findings summarized in recent reviews.^{1,2,19}

The benefit of significantly reduced patient discomfort may be immediately relevant in cultural settings where unsedated colonoscopy or minimally sedated colonoscopy is practiced. In settings where advanced sedation is the norm, pain reduction

offered by water exchange may not be a sufficient incentive for its incorporation into practice. Overseas investigators reported that traditional colonoscopy failed to reduce colorectal cancer mortality in the right colon as effectively as in the left colon.³⁸⁻⁴⁰ The most recent assessments of epidemiologic data in the U.S.^{41,42} have confirmed these shortcomings of traditional colonoscopy. The possible increase in ADR by water exchange especially in the proximal colon suggests that production pressure which has been linked to jeopardized colonoscopy quality⁴³ need not be the sole justification for overlooking methodological details of water exchange.

In conclusion the data in this observational study provide the proof-of-principle confirmation that understanding of the nuances of the water exchange method can be acquired efficiently by direct coaching during hands on practice.

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Disclosure

The authors have no conflict of interest to disclose relevant to this manuscript.

References

1. Leung FW, Harker JO, Leung JW, Siao-Salera RM, Mann SK, Ramirez FC, et al. Removal of infused water predominantly during insertion (water exchange) is consistently associated with a greater reduction of pain score—review of randomized controlled trials (RCTs) of water method colonoscopy. *J Interv Gastroenterol* 2011; 1:114-20.
2. Leung FW, Harker JO, Leung JW, Siao-Salera RM, Mann SK, Ramirez FC, et al. Removal of infused water predominantly during insertion (water exchange) is consistently associated with an increase in adenoma detection rate—review of data in randomized controlled trials (RCTs) of water-related methods. *J Interv Gastroenterol* 2011; 1:121-6.
3. Leung FW. Water exchange may be superior to water immersion for colonoscopy (editorial). *Clin Gastroenterol Hepatol* 2011; 9:1012-4.
4. Falchuk ZM, Griffin PH. A technique to facilitate colonoscopy in areas of severe diverticular disease (letter). *N Engl J Med* 1984; 310:598.
5. Baumann UA. Water intubation of the sigmoid colon: water instillation speeds up left-sided colonoscopy. *Endoscopy* 1999; 31:314-7.
6. Church JM. Warm water irrigation for dealing with spasm during colonoscopy: simple, inexpensive, and effective. *Gastrointest Endosc* 2002; 56:672-4.
7. Hamamoto N, Nakanishi Y, Morimoto N, Inoue H, Tatukawa M, Nakata S, et al. A new water instillation method for colonoscopy without sedation as performed by endoscopists-in-training. *Gastrointest Endosc* 2002; 56:825-8.
8. Brocchi E, Pezzilli R, Tomassetti P, Campana D, Morselli-Labate AM, Corinaldesi R. Warm water or oil-assisted colonoscopy: toward simpler examinations? *Am J Gastroenterol* 2008; 103:581-7.
9. Rex DK. Water infusion vs. air insufflation during colonoscopy. *J Watch Gastroenterol*, 2009.
10. Ransibrahmanakul K, Leung JW, Mann SK, Siao-Salera R, Lim BS, Hasyagar C, et al. Comparative effectiveness of water vs. air methods in minimal sedation colonoscopy performed by supervised trainees in the US—a RCT. *Am J Clin Med* 2010; 7:113-8.
11. Leung CW, Kaltenbach T, Soetikno R, Wu KK, Leung FW, Friedland S. Colonoscopy insertion technique using water immersion versus standard technique: a randomized trial showing promise for minimal-sedation colonoscopy. *Endoscopy* 2010; 42:557-62.
12. Radaelli F, Paggi S, Amato A, Terruzzi V. Warm water infusion versus air insufflation for unsedated colonoscopy: a randomized, controlled trial. *Gastrointest Endosc* 2010; 72:701-9.
13. Park SC, Keum B, Kim ES, Jung ES, Lee SD, Park S, et al. Usefulness of warm water and oil assistance in colonoscopy by trainees. *Dig Dis Sci* 2010; 55:2940-4.
14. Friedland S. The water immersion technique for colonoscopy insertion. *Gastroenterol Hepatol* 2010; 6:555-6.

15. Frossard JL, Gervaz P, Huber O. Water-immersion sigmoidoscopy to treat acute GI bleeding in the perioperative period after surgical colorectal anastomosis. *Gastrointest Endosc* 2010; 71:167-70.
16. Hsieh YH, Lin HJ, Tseng KC. Limited water infusion decreases pain during minimally sedated colonoscopy. *World J Gastroenterol* 2011; 17:2236-40.
17. Hsieh YH, Tseng KC, Hsieh JJ, Tseng CW, Hung TH, Leung FW. Feasibility of colonoscopy with water infusion in minimally sedated patients in an Asian community setting. *J Interv Gastroenterol* 2011; 1:185-90.
18. Pohl J, Messer I, Behrens A, Kaiser G, Mayer G, Ell C. Water infusion for cecal intubation increases patient tolerance, but does not improve intubation of unsedated colonoscopies. *Clin Gastroenterol Hepatol* 2011; 9:1039-43.
19. Leung FW, Amato A, Ell C, Friedland S, Harker JO, Hsieh YH, et al. Water-aided colonoscopy: a systematic review. *Gastrointest Endosc* 2012, in press.
20. Leung FW. Is there a place for sedationless colonoscopy? *J Interv Gastroenterol* 2011; 1:19-22.
21. Leung FW, Leung JW, Mann SK, Friedland S, Ramirez FC. Innovation Forum—The water method significantly enhances patient-centered outcomes in sedated and unsedated colonoscopy. *Endoscopy* 2011; 43:816-21.
22. Leung FW. Prevalence and predictors of interval colorectal cancers—what hypotheses should colonoscopists consider in planning studies to modify the undesirable outcome. *Ann Gastroenterol* 2012, in press.
23. Leung FW. Magnetic endoscope imaging colonoscopy—a new modality for hypothesis-testing in unsedated colonoscopy. *Gastrointest Endosc* 2012; 75:1037-9.
24. Leung FW. Methods of reducing discomfort during colonoscopy. *Dig Dis Sci* 2008; 53:1462-7.
25. Leung FW. Water-related method for performance of colonoscopy. *Dig Dis Sci* 2008; 53:2847-50.
26. Leung FW, Aharonian HS, Guth PH, Chu SK, Nguyen BD, Simpson P. Involvement of trainees in routine unsedated colonoscopy—review of pilot experience. *Gastrointest Endosc* 2008; 67:718-22.
27. Leung FW. Unsedated colonoscopy introduced as a routine option to ensure access is acceptable to a subgroup of US veterans. *Dig Dis Sci* 2008; 53:2719-22.
28. Leung FW. Promoting informed choice of unsedated colonoscopy - patient-centered care for a subgroup of U.S. veterans. *Dig Dis Sci* 2008; 53:2955-9.
29. Leung FW, Aharonian HS, Leung JW, Guth PH, Jackson G. Impact of a novel water method on scheduled unsedated colonoscopy in U.S. veterans. *Gastrointest Endosc* 2009; 69:546-50.
30. Leung JW, Mann S, Leung FW. Option for screening colonoscopy without sedation—a pilot study in United States veterans. *Aliment Pharmacol Ther* 2007; 26:627-31.
31. Leung JW, Salera R, Toomsen L, Mann S, Leung FW. A pilot feasibility study of the method of water infusion without air insufflation in sedated colonoscopy. *Dig Dis Sci* 2009; 54:1997-2001.
32. Mizukami T, Yokoyama A, Imaeda H, Kumai K. Collapse-submergence method: simple colonoscopic technique combining water infusion with complete air removal from the rectosigmoid colon. *Dig Endosc* 2007; 19:43-8.
33. Leung JW, Mann SK, Siao-Salera R, Ransibrahmanakul K, Lim B, Cabrera H, et al. Randomized controlled comparison of warm water infusion in lieu of air insufflation vs. air insufflation for aiding colonoscopy insertion in sedated patients undergoing colorectal cancer (CRC) screening and surveillance. *Gastrointest Endosc* 2009; 70:505-10.
34. Leung FW, Harker JO, Jackson G, Okamoto KE, Behbahani OM, Jamgotchian NJ, et al. A proof-of-principle, prospective, randomized controlled trial (RCT) demonstrating improved outcomes in scheduled unsedated colonoscopy by the water method. *Gastrointest Endosc* 2010; 72:693-700.
35. Leung JW, Mann SK, Siao-Salera RM, Ransibrahmanakul K, Lim BS, Canete W, et al. A randomized, controlled trial to confirm the beneficial effects of the water method on U.S. veterans undergoing colonoscopy with the option of on-demand sedation. *Gastrointest Endosc* 2011; 73:103-10.
36. Ramirez FC, Leung FW. The water method for aiding colonoscopy insertion: the learning curve of an experienced colonoscopist. *J Interv Gastroenterol* 2011; 1(3):97-101.
37. Ramirez FC, Leung FW. A head-to-head comparison of the water vs. air method in patients undergoing screening colonoscopy. *J Interv Gastroenterol* 2011; 1:135-140.
38. Baxter NN, Goldwasser MA, Paszat LF, Saskin R, Urbach DR, Rabeneck L. Association of colonoscopy and death from colorectal cancer: a population-based, case-control study. *Ann Intern Med* 2009; 150:1-8.
39. Brenner H, Hoffmeister M, Arndt V, Stegmaier C, Altenhofen L, Haug U. Protection from right- and left-sided colorectal neoplasms after colonoscopy: population-based study. *J Natl Can Inst* 2010; 102:89-95.
40. Brenner H, Chang-Claude J, Seiler CM, Rickert A, Hoffmeister M. Protection from colorectal cancer after colonoscopy: a population-based, case-control study. *Ann Intern Med* 2011; 154:22-30.
41. Stock C, Pulte D, Haug U, Brenner H. Subsite-specific colorectal cancer risk in the colorectal endoscopy era. *Gastrointest Endosc* 2011; 75(3):621-630.
42. Cooper GS, Xu F, Barnholtz Sloan JS, Schluchter MD, Koroukian SM. Prevalence and predictors of interval colorectal cancers in Medicare beneficiaries. *Cancer* 2011 Oct 11. doi:
43. Whitson MJ, Bodian CA, Aisenberg J, Cohen LB. Is production pressure jeopardizing the quality of colonoscopy? A survey of U.S. endoscopists' practices and perceptions. *Gastrointest Endosc* 2012; 75:641-8.