

# Water immersion sigmoidoscopy versus standard insufflation for colorectal cancer screening: A cohort study

Calcedonio Calcara, Paolo Aseni<sup>1</sup>, Keith Siau<sup>2</sup>, Pietro Gambitta<sup>3</sup>, Sergio Cadoni<sup>4</sup>

Department of Gastroenterology ASST Ovest Milanese, Magenta, <sup>1</sup>Department of Emergency Medicine, ASST Niguarda Hospital, Milan,

<sup>3</sup>Department of Gastroenterology, ASST Ovest Milanese, Legnano, <sup>4</sup>Department of Gastroenterology, CTO Hospital, Iglesias, Italy,

<sup>2</sup>Department of Gastroenterology, Dudley Group Hospitals NHS Foundation Trust, Dudley, United Kingdom

## Abstract

**Background:** Although the efficacy of water-assisted colonoscopy is well established, the role of water immersion sigmoidoscopy (WIS) remains unclear. We compared WIS with carbon dioxide insufflation sigmoidoscopy (CO<sub>2</sub>S) on patient outcomes.

**Methods:** We conducted an analysis of prospectively collected data from a single-center quality improvement program about patients undergoing unsedated screening sigmoidoscopy (WIS and CO<sub>2</sub>S) between May 2019 and January 2020. Outcomes studied included the following: Rates of severe pain <17% (score of  $\geq 7$  on a numeric rating scale of 0–10, and on a Likert scale), willingness to repeat the procedure without sedation, adequate bowel cleanliness >75% (proportion of Boston Bowel Preparation Scale score: 2–3) and adenoma detection rate (ADR).

**Results:** In total, 234 patients (111 WIS; 123 CO<sub>2</sub>S) were included. All patients were aged 58 years and 58.9% were female; baseline characteristics were comparable between groups. There were no significant differences in rates of severe pain (WIS: 16.5%, CO<sub>2</sub>S: 13.8%;  $P = 0.586$ ), willingness to repeat the unsedated procedure (WIS: 82.3%, CO<sub>2</sub>S: 84.5%;  $P = 0.713$ ), adequate bowel cleanliness (WIS: 78.4%, CO<sub>2</sub>S: 78%,  $P = 0.999$ ) or ADR (WIS: 25.2%, CO<sub>2</sub>S: 16.3%;  $P = 0.106$ ) between groups. However, average procedure times were longer with WIS (9.06 min) compared to CO<sub>2</sub>S (6.45 min;  $P < 0.001$ ). Overall, 29.6% of women reported that they would repeat sigmoidoscopy only if sedated.

**Conclusions:** WIS does not ameliorate tolerance to and quality of sigmoidoscopy screening measured by several scores. When offered a choice, the women's willingness to repeat WIS or CO<sub>2</sub>S without sedation was poor and raises concern on the opportunity of screening sigmoidoscopy without sedation in these subjects.

**Keywords:** Adenoma detection rate, colon cleanliness, procedural pain

**Address for correspondence:** Dr. Calcedonio Calcara, Department Of Gastroenterology, ASST Ovest Milanese, Magenta, Italy. Postal Address: Fornaroli Hospital, Via al Donatore di Sangue N° 50, Magenta, 20013, MI, Italy.

E-mail: ccalcara@libero.it

**Submitted:** 11-Apr-2021 **Revised:** 17-Jul-2021 **Accepted:** 31-Jul-2021 **Published:** 06-Sep-2021

## INTRODUCTION

Sigmoidoscopy screening reduces mortality from colorectal cancer (CRC) and has been adopted as a screening strategy

in the UK,<sup>[1]</sup> Canada,<sup>[2]</sup> Italy,<sup>[3]</sup> the USA,<sup>[4,5]</sup> and Norway.<sup>[6]</sup> Procedures are usually conducted in a day care setting without sedation and with enema preparation, leading to procedural

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

**For reprints contact:** WKHLRPMedknow\_reprints@wolterskluwer.com

**How to cite this article:** Calcara C, Aseni P, Siau K, Gambitta P, Cadoni S. Water immersion sigmoidoscopy versus standard insufflation for colorectal cancer screening: A cohort study. Saudi J Gastroenterol 2022;28:39-45.

Access this article online	
Quick Response Code:	Website: www.saudijgastro.com
	DOI: 10.4103/sjg.sjg_198_21

discomfort and limited mucosal views, respectively. Carbon dioxide insufflation (CO<sub>2</sub>) instead of room air insufflation decreases post-procedural discomfort and is routinely used in some countries during colonoscopy.<sup>[7-9]</sup>

Over the last two decades, there has been increasing evidence in support of the role of water-assisted colonoscopy (WAC). This entails the use of water instead of gas (room air or CO<sub>2</sub>) insufflation to distend the lumen to allow instrument progression during sigmoidoscopy and/or colonoscopy.<sup>[10-12]</sup> Infused water is removed predominantly during the withdrawal (water immersion, WI) or during the insertion phase (water exchange, WE).<sup>[12,13]</sup> WAC shortens and straightens the sigmoid colon facilitating passage into the descending segment and decreases discomfort.<sup>[10,12,13]</sup>

Considering that sigmoidoscopy is a part of a complete colonoscopic examination, it seems reasonable to extend to it the benefits shown by WAC.<sup>[10]</sup> However, few studies have evaluated the role of water immersion sigmoidoscopy (WIS) in the screening population.

In this study, we analyzed prospectively the data collected from a quality improvement program aimed to compare WIS with CO<sub>2</sub> sigmoidoscopy (CO<sub>2</sub>S) on patient outcomes and to compare them with available quality standards in sigmoidoscopy.<sup>[14-16]</sup>

## PATIENTS AND METHODS

### Study design

We conducted a prospective analysis of the data collected from a single-center quality improvement program aimed to monitor and improve quality parameters using WIS and CO<sub>2</sub>S in patients undergoing primary unsedated CRC screening sigmoidoscopy. In accordance with our regional screening protocol (Piedmont, Italy), all 58-year-olds were invited for primary CRC sigmoidoscopy screening. Exclusion criteria included a personal history of CRC, colorectal adenomas or inflammatory bowel disease, colorectal endoscopy done within the previous 2 years, having two or more first-degree relatives with CRC, and having a medical condition that would preclude a benefit from screening.<sup>[17]</sup> Between May 2019 and January 2020, participating patients at the Gastroenterology Unit of the S.S. Trinità Borgomanero Hospital (ASL Novara, Piedmont Region, Italy) were included in the quality improvement program. This program was exempted from approval of the local Ethics Committee, which was notified that the anonymized and aggregated data would be analyzed and used for publication. Signed informed consent was obtained from the patients before the procedure.

### Outcomes

In the absence of standardized performance measures specifically developed for monitoring quality in sigmoidoscopy, we chose to ascertain if compared with literature data, severe pain would be <17% of the procedures,<sup>[14]</sup> adequate bowel cleanliness >75%, and adenoma detection rate (ADR, proportion of patients with at least one adenoma removed) >10%.<sup>[15,16]</sup>

The primary outcomes of the quality improvement program were severe pain during the procedure in <17% of cases [assessed through the use of a numerical rating scale (NRS) with 0 = no pain to 10 = maximum pain and a simplified Likert scale (no pain, mild pain, severe pain)],<sup>[18]</sup> and patients' willingness to repeat the procedure in the future without sedation.

Secondary outcomes were adequate bowel cleanliness in >75% of the procedures [measured according to the validated Boston Bowel Preparation Scale (BBPS) relative to the distal colon segment explored and defined as BBPS score  $\geq 2$ ],<sup>[19]</sup> ADR and polyp detection rate (PDR; the proportion of patients with at least one polyp removed), and bloating during the procedure (NRS with 0 = none, 10 = full bloating).

Before starting the procedure, a questionnaire recording the demographic data, previous abdominal surgery, comorbidities, and current medications was administered by the endoscopist (CC), that also explained the scoring systems (NRS and Likert scale) to the patients, who were also asked if they expected the procedure to be painless, slightly painful or very painful.

At the end of the examination, the colonoscopist that did all the procedures (CC) recorded patients' pain during the procedure on the NRS and bloating. At discharge (approximately 5 minutes after the examination), the colonoscopist recorded recalled pain using the Likert scale and made a note of patients' willingness to repeat the procedure in the future without sedation.

Pathology records were reviewed to evaluate ADR, to which contributed adenomas resected at sigmoidoscopy, and those found during this procedure and subsequently relocated and removed at a successive colonoscopy.

### Procedures

No dietetic regimen was suggested to patients; bowel cleansing was obtained only by a self-administered 133-ml phosphate enema 2 hours before the procedure. WIS was performed on odd days and usual CO<sub>2</sub>S on even days. The endoscopist (CC) had experience in

more than 14,000 colonoscopies and routinely used WI colonoscopy and WIS in clinical practice since 2017 (about 400 WI and WIS accrued at the beginning of the study). All examinations were carried out using high-definition adult colonoscopes (Olympus CF-HQ190, Olympus Europa SE and Co., Hamburg, Germany), an Olympus UCR CO<sub>2</sub> insufflation unit, and an Olympus OFP-2 water pump.

Sigmoidoscopy began with the patients in the left lateral position, without premedication. With the CO<sub>2</sub> insufflation pump turned off, WIS entailed infusion of water to distend the lumen to allow instrument insertion without restriction of the overall volume of water infused.<sup>[12]</sup> Murky water and/or feces were removed when necessary to safely allow colonoscope progression but without maximizing cleanliness; however, infused water was removed predominantly during withdrawal.<sup>[12,13]</sup> Residual gas pockets were not always aspirated but could also be used to bypass dirty colon content.<sup>[12]</sup> CO<sub>2</sub>S was performed with the minimal insufflation required to distend the lumen, allowing for washing as needed to clear the view. In all procedures, withdrawal was carried out using CO<sub>2</sub> insufflation, and washing as necessary to obtain a clear view of the mucosa.

A stopwatch was used to time the procedures. Procedure time is defined as the time from instrument insertion to the anus up at least to the distal descending colon (where the examination was considered to be complete as per study protocol) or to the reach of the scope, and withdrawal from the anus. Loop reduction, position change, and abdominal compression were applied as needed during insertion in both groups. Polyps were resected either during insertion or withdrawal; lesions ≤3 mm were removed with biopsy forceps, larger lesions were resected using a cold snare, if appropriate. Patients with large lesions needing hot polypectomy were scheduled for a successive colonoscopy. As the CRC sigmoidoscopy screening protocol did not allow the use of on-demand sedation, if the patient asked to stop the procedure due to pain, the examination was interrupted, considered incomplete, and the patient was scheduled for a sedated colonoscopy.

In case of incomplete procedures due to poor bowel preparation, patients were rescheduled to another sigmoidoscopy, preceded by three days of low-fiber diet and bowel preparation with two self-administered enemas 2 hours before the procedure. Data of these examinations are not part of our analyses.

### Statistical analysis

Intention-to-treat analyses were conducted using IBM SPSS Statistics version 23.0 (IBM Corp, Armonk, NY, USA).

De-identified data are summarized with mean and standard deviation (SD), and/or median and inter-quartile range for continuous variables; or n and % for categorical variables. Categorical variables were compared by the Chi-square test. Continuous variables were assessed by *t*-test or nonparametric Mann–Whitney U test, as appropriate. *P* < 0.05 was considered significant.

## RESULTS

In total, 234 patients were enrolled, of whom 111 underwent WIS and 123 CO<sub>2</sub>S [Figure 1]. All patients were aged 58 years and 58.9% were female. Some demographic and/or procedural data relative to 20 cases were lost from analyses. There were no significant differences in demographic profiles [Table 1], rates of previous abdominal surgery, and the presence of diverticulosis between the WIS and CO<sub>2</sub>S groups, attesting that the two groups were similar cohorts.

Based on the primary outcome [Table 2 and Figure 2], procedures with severe pain on the NRS (score: ≥7) were met in 16.5% in the WIS group and 13.8% in the CO<sub>2</sub>S group (*P* = 0.586). When measured on the Likert scale, rates of severe pain were comparable between groups (WIS: 11.7%, CO<sub>2</sub>S: 9.8%; *P* = 0.526). This did not vary in the subgroup analysis of female patients for pain scores measured on the NRS (WIS: 33.3% vs. CO<sub>2</sub>S: 26.1% on the NRS; *P* = 0.497) and on the Likert scale (WIS: 26.7% vs. CO<sub>2</sub>S: 19.6%; *P* = 0.454). Mean maximum pain score (SD) during the procedure was comparable between groups: WIS 3.6 (2.4) vs. CO<sub>2</sub>S 3.5 (2.4); as well as recalled pain score recorded on the Likert scale. Overall, with comparable patients' expectations about the level of pain associated with the examination, the majority were willing to repeat the

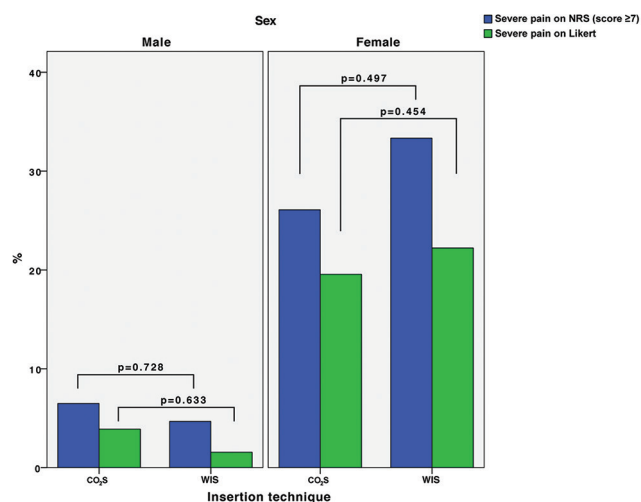


Figure 1: Study flow chart

**Table 1: Demographics details**

	Water immersion sigmoidoscopy (WIS) n=111	CO <sub>2</sub> insufflation sigmoidoscopy (CO <sub>2</sub> S) n=123	P
Sex n (%)			
Female	45 (40.5)	46 (37.4)	0.688 <sup>a</sup>
Male	66 (59.5)	77 (62.6)	
Age, mean (SD), years	58 (0)	58 (0)	NA
BMI, mean (SD), kg/m <sup>2</sup>	25.2 (3.7)	25.8 (4.3)	0.167 <sup>b</sup>
	n=101/111	n=118/123	
Previous abdominal surgery, n (%)	34 (34.0)	35 (29.9)	0.560 <sup>a</sup>
	n=100/111	n=117/123	
Diverticulosis, n (%)	37 (33.3)	35 (28.5)	0.479 <sup>a</sup>
	n=100/111	n=117/123	

SD, Standard deviation; <sup>a</sup>Fisher exact test; <sup>b</sup>t-Test; NA, not allowed

procedure in future without sedation (WIS: 82.3%, CO<sub>2</sub>S: 84.5%, *P* = 0.713). However, in the WIS and CO<sub>2</sub>S groups, 33.3% and 27.3% of females, respectively, were willing to repeat the procedure only with sedation (*P* = 0.485).

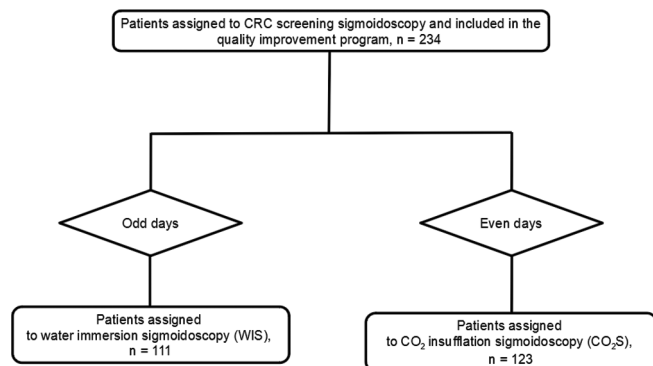
Also, all other procedural outcomes were comparable [Table 2], with the exception of procedure time (with and without polypectomy), which was significantly longer (*P* < 0.001) using WIS: Mean minutes (SD) WIS: 9.06 (3.4), CO<sub>2</sub>S: 6.45 (2.9); WIS: 8.27 (3.2), CO<sub>2</sub>S: 5.76 (2.4), respectively.

Adequate cleanliness (BBPS: 2–3) was achieved in 78.4% of cases in the WIS group and 78.0% in the CO<sub>2</sub>S group; WIS showed higher, but comparable ADR (25.2%) than CO<sub>2</sub>S 16.3% (*P* = 0.106).

Due to inadequate lumen visualization for instrument progression, in one case the insertion technique was changed from WIS to CO<sub>2</sub>S; no changes occurred in the CO<sub>2</sub>S group.

**DISCUSSION**

To the best of our knowledge, this is the first study to assess the impact of WIS and CO<sub>2</sub>S on Italian patients undergoing



**Figure 2:** Proportion of severe pain by gender and insertion technique, recorded just after the examination (score of ≥7 on NRS) and at discharge (Likert scale). CO<sub>2</sub>S: carbon dioxide insufflation sigmoidoscopy; NRS: Numerical rating scale; WIS: water immersion sigmoidoscopy

primary unsedated CRC screening sigmoidoscopy. In our study, the outcomes selected for the quality improvement study were comparable between WIS and CO<sub>2</sub>S and all were above the suggested sigmoidoscopy quality standards. WIS was not superior to CO<sub>2</sub>S in decreasing procedure pain, particularly in female patients that reported severe pain more frequently than males, and in increasing BBPS, PDR, and ADR (WIS increased the latter, but not significantly).

Colonoscopy is the main examination method for CRC screening around the world.<sup>[20]</sup> However, some countries have included sigmoidoscopy as an available option in their CRC screening programs,<sup>[1-6]</sup> exploiting the opportunity to offer alternate tests when patients decline colonoscopy.<sup>[21]</sup> To date, four randomized controlled trials (RCT) have demonstrated that a single flexible sigmoidoscopy examination at around age 60 years reduces CRC incidence by 18%–23% and mortality by 22%–33%,<sup>[1,3,4,22]</sup> providing substantial protection from CRC diagnosis and death, lasting up to 17 years.<sup>[23]</sup>

Sigmoidoscopy is a fast and safe procedure. Its advantages include lower cost and risk compared with colonoscopy and a more limited bowel preparation. Its disadvantages include a lower protection against right-sided colon cancer, and in case of unsedated procedures, as is usually planned in population-based screening programs,<sup>[1-6,24]</sup> a low satisfaction experience for patients, as our study confirmed.

Tolerance of sigmoidoscopy and willingness to repeat the procedure are critical points.<sup>[14,24-27]</sup> In our quality improvement program, we assessed patients’ experience with sigmoidoscopy, an important quality domain,<sup>[28]</sup> by the proxy of willingness to repeat it in the future, a comprehensive item for assessing tolerance encompassing social and examination-related issues.<sup>[25]</sup> Unfortunately, 29.6% of females were willing to repeat sigmoidoscopy only with sedation (WIS: 33.3%; CO<sub>2</sub>S: 27.3%). This raises concerns about the opportunity of using unsedated sigmoidoscopy for CRC screening in this cohort of



**Table 2: Procedural data**

	Water immersion sigmoidoscopy (WIS) <i>n</i> =111	CO <sub>2</sub> insufflation sigmoidoscopy (CO <sub>2</sub> S) <i>n</i> =123	P
Severe pain, NRS score ≥7, <i>d</i> (%)			
Overall	16.5 <i>n</i> =109/111	13.8	0.586 <sup>a</sup>
Women	33.3	26.1	0.497 <sup>a</sup>
Men	4.7 <i>n</i> =64/66	6.5	0.728 <sup>a</sup>
Pain score during the procedure, <i>d</i> mean (SD) [median, 95% CI]			
Overall	3.6 (2.4) [3.0, 3.1–4.0] <i>n</i> =109/111	3.5 (2.4) [3.0, 3.1–3.9]	0.830 <sup>b</sup> 0.527 <sup>c</sup>
Women	5.0 (2.4) [5.0, 4.3–5.7]	4.2 (2.6) [4.0, 3.5–5.0]	0.153 <sup>b</sup> 0.132 <sup>c</sup>
Men	2.6 (1.8) [2.0, 2.2–3.0] <i>n</i> =64/66	3.1 (2.1) [3.0, 2.6–3.6]	0.136 <sup>b</sup> 0.174 <sup>c</sup>
Recalled pain score, <sup>e</sup> <i>n</i> (%)			
No pain			
Overall	32 (28.8) <i>n</i> =96/111	35 (28.5) <i>n</i> =115/123	0.884 <sup>a</sup>
Women	8 (17.8) <i>n</i> =41/45	9 (19.6) <i>n</i> =43/46	>0.999 <sup>a</sup>
Men	24 (36.4) <i>n</i> =55/66	26 (33.8) <i>n</i> =72/77	0.464 <sup>a</sup>
Mild pain			
Overall	51 (45.9) <i>n</i> =96/111	68 (55.3) <i>n</i> =115/123	0.405 <sup>a</sup>
Women	21 (46.7) <i>n</i> =43/45	25 (54.3) <i>n</i> =43/46	0.517 <sup>a</sup>
Men	30 (45.5) <i>n</i> =55/66	43 (55.8) <i>n</i> =72/77	0.591 <sup>a</sup>
Severe pain			
Overall	13 (11.7) <i>n</i> =96/111	12 (9.8) <i>n</i> =115/123	0.526 <sup>a</sup>
Women	12 (26.7) <i>n</i> =41/45	9 (19.6) <i>n</i> =43/46	0.454 <sup>a</sup>
Men	1 (1.5) <i>n</i> =55/66	3 (3.9) <i>n</i> =72/77	0.633 <sup>a</sup>
Willingness to repeat the procedure only with the addition of sedation, <i>n</i> (%), overall	17 (17.7) <i>n</i> =96/111	18 (15.5) <i>n</i> =116/123	0.713 <sup>a</sup>
Willingness to repeat the procedure only with the addition of sedation, <i>n</i> (%), females	15 (33.3) <i>n</i> =41/45	12 (27.3) <i>n</i> =44/46	0.485 <sup>a</sup>
Adequate prep (BBPS score 2 or 3), <i>n</i> (%)	87 (78.4)	96 (78.0)	>0.999 <sup>b</sup>
BBPS score, mean (SD)	2.1 (1.1)	2.1 (1.1)	>0.999 <sup>b</sup>
Adenoma detection rate, <i>n</i> (%)	28 (25.2)	20 (16.3)	0.106 <sup>a</sup>
Polyp detection rate, <i>n</i> (%)	41 (36.9)	35 (28.5)	0.208 <sup>a</sup>
Examinations completed (reached at least the distal descending colon)	100 (90.1)	107 (87.0)	0.541 <sup>a</sup>
Incomplete procedures			
Intolerance, <i>n</i> (%)	6 (5.4)	4 (3.3)	0.524 <sup>a</sup>
Poor prep, <i>n</i> (%)	4 (3.6)	12 (9.8)	0.073 <sup>a</sup>
Adhesions or bends, <i>n</i> (%)	1 (0.9)	0	N <sup>a</sup>
Procedure time, mean minutes (SD)	9.06 (3.4)	6.45 (2.9)	<0.001 <sup>b</sup>
Procedure time, cases without polypectomy, mean minutes (SD)	8.27 (3.2)	5.76 (2.4)	<0.001 <sup>b</sup>
Bloating during the procedure, <sup>f</sup> mean (SD)	3.5 (2.2)	3.9 (2.2)	0.200 <sup>b</sup>
Do you think that the procedure will be <sup>s</sup>			
Overall Painless, <i>n</i> (%)	29 (29.9) <i>n</i> =97/111	33 (28.9) <i>n</i> =114/123	>0.999 <sup>a</sup>
Overall Slightly painful, <i>n</i> (%)	29 (29.9) <i>n</i> =97/111	36 (31.6) <i>n</i> =114/123	0.881 <sup>a</sup>
Overall Very painful, <i>n</i> (%)	9 (9.3)	7 (6.1) <i>n</i> =114/123	0.441 <sup>a</sup>
Overall Doesn't know, <i>n</i> (%)	30 (30.9) <i>n</i> =97/111	38 (33.3) <i>n</i> =114/123	0.768 <sup>a</sup>

SD, Standard deviation; BBPS, Boston Bowel Preparation Scale. <sup>a</sup>Fisher exact test; <sup>b</sup>t-test; <sup>c</sup>Mann-Whitney *U* test; <sup>d</sup>Measured at the end of procedure on a Numerical Rating Scale (NRS): 0=no pain, 10=maximum pain; <sup>e</sup>Modified Likert scale: No pain, mild pain, severe pain; <sup>f</sup>Measured at the end of procedure on an NRS: 0=no bloating, 10=full bloating; <sup>g</sup>Data recorded before the procedure

patients. Finding ways to substantially decrease the pain score in this subset of patients has important clinical implications and should be a research priority.<sup>[25,28]</sup>

We selected the easy-to-use WI technique to facilitate the progression of the instrument through the sigmoid colon.<sup>[10]</sup> Unfortunately, bowel preparation with one enema 2 hours before the procedure left residual solid feces and debris; this hampered infusing and aspirating water keeping lumen distention to a minimum to safely insert the instrument. In addition, sometimes, water infusion promoted the transit of feces from the descending to the sigmoid colon, further hindering the WI technique. This suboptimal way to perform WI might explain its lack of impact on decreasing the pain score.

Moreover, WI is not the least painful colonoscopy technique for the examination of the lower gastrointestinal tract,<sup>[12,13]</sup> and with only one exception,<sup>[29]</sup> compared with CO<sub>2</sub> insufflation, WI did not improve colon cleanliness and in all published RCTs did not increase ADR.<sup>[13]</sup>

On the contrary, WE (gasless insertion in clear water, maximizing cleanliness with minimal lumen distension) is the least painful insertion technique and has been associated with an increase in both colon cleanliness and ADR.<sup>[13,30]</sup> However, we could not perform WE because the bowel preparation used would have hindered its application even more than WI.

A single enema 2 hours before sigmoidoscopy is a good option that cleans the distal bowel and facilitates tolerance by patients.<sup>[15,31,32]</sup> Future studies should investigate if a different preparation could give the opportunity to use WE, e.g. one additional enema 1 hour before the examination, as suggested by our CRC screening sigmoidoscopy protocol in the case of rescheduled procedures due to poor cleanliness. WE frequently allows an extended view beyond the splenic flexure (and in the best scenario, an entire complete colon examination) without the costs and potential side-effects of a sedated colonoscopy.<sup>[11]</sup>

Our observations seem to support in part the results of a recent multicenter CRC screening sigmoidoscopy trial conducted within the English Bowel Scope Screening.<sup>[24]</sup> However, in our study, we found some differences that deserve consideration. Our data show that BBPS was comparable between groups, this notwithstanding lesion detection [Table 2] was higher (even if comparable) in the WIS group than in the CO<sub>2</sub>S group. In the WASH trial, ADR and PDR using WIS or CO<sub>2</sub> insufflation were 8% and 12%, and 26% and 26%, respectively; in the current study, they were 25.2% and 16.3%, and 36.9% and 28.5%, respectively. A possible explanation could be the

difference in colonoscopists' expertise: In our study experience in about 400 WI procedures, in the WASH study, only 20 procedures were required to attest expertise in WIS.

ADR is also a function of time spent searching for lesions.<sup>[33,34]</sup> The difference in overall procedure time between the two arms of the WASH trial was 43 s (WIS: 8.83 min; CO<sub>2</sub> insufflation: 8.12 min); this small difference can possibly explain the lower ADR achieved by WIS. Indeed, in our study [Table 2], the difference in total procedure time between WIS and CO<sub>2</sub>S was 2.21 min (all procedures) and 1.51 min (procedures without polypectomy). Unfortunately, we did not keep a separate record of insertion time. However, considering that withdrawal was done similarly in both groups striving to search for lesions, in our study, the difference in procedure times can be reasonably accounted for by the time spent infusing and also aspirating water when necessary. Anecdotally (we did not record in which phase of the examination lesions were resected), during insertion, WIS provided increased visualization of polyps floating into the lumen that were resected during this phase or relocated and removed during withdrawal.

We acknowledge some limitations. First, ours is a not randomized study and there was some loss of data. Second, procedures and data recording were performed by a single, unblinded colonoscopist. Our study also has strengths. Patients—although not randomized—were casually allocated to WIS or CO<sub>2</sub>S, and the use of both techniques reflects actual clinical practice. Pain score was not affected by the use of sedation. We assessed patients' experience, an important quality domain, by the proxy of willingness to repeat in the future "only if sedated" or "without sedation"; and we used a validated scale to measure bowel cleanliness.<sup>[19]</sup> Finally, the colonoscopist had expertise in both WI and WIS.

In conclusion, in our study both WIS and CO<sub>2</sub>S met and improved selected sigmoidoscopy quality standards, but WIS was not superior to CO<sub>2</sub>S in decreasing pain score; increased BBPS, PDR, and ADR; and required a significantly longer procedure time.

When a choice was offered, women's willingness to repeat WIS or CO<sub>2</sub>S without sedation was poor. This result raises concern on the opportunity of screening sigmoidoscopy without sedation in females. Future studies should assess the impact of different bowel preparation and water-assisted sigmoidoscopy technique on these quality indicators, and their impact on the pain score in female patients.

#### Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

## REFERENCES

- Atkin WS, Edwards R, Kralj-Hans I, Wooldrage K, Hart AR, Northover JM, et al. Once-only flexible sigmoidoscopy screening in prevention of colorectal cancer: A multicentre randomised controlled trial. *Lancet* 2010;375:1624-33.
- Singh H, Samadder NJ, Guha S. Flexible sigmoidoscopy for colorectal cancer screening in Canada. *Can J Gastroenterol Hepatol* 2014;28:21-2.
- Segnan N, Armaroli P, Bonelli L, Risio M, Sciallero S, Zappa M, et al. Once-only sigmoidoscopy in colorectal cancer screening: Follow-up findings of the Italian randomized controlled trial-SCORE. *J Natl Cancer Inst* 2011;103:1310-22.
- Schoen RE, Pinsky PF, Weissfeld JL, Yokochi LA, Church T, Laiyemo AO, et al. Colorectal-cancer incidence and mortality with screening flexible sigmoidoscopy. *N Engl J Med* 2012;366:2345-57.
- US Preventive Services Task Force. Screening for colorectal cancer US preventive services task force recommendation statement *JAMA* 2021;325:1965-77.
- Holme Ø, Løberg M, Kalager M, Bretthauer M, Hernán MA, Aas E, et al. Long-term effectiveness of sigmoidoscopy screening on colorectal cancer incidence and mortality in women and men: A randomized trial. *Ann Intern Med* 2018;168:775-82.
- Rogers AC, Van De Hoef D, Sahebally SM, Winter DC. A meta-analysis of carbon dioxide versus room air insufflation on patient comfort and key performance indicators at colonoscopy. *Int J Colorectal Dis* 2020;35:455-64.
- Bretthauer M, Hoff G, Thiis-Evensen E, Grotmol T, Holmsen ST, Moritz V, et al. Carbon dioxide insufflation reduces discomfort due to flexible sigmoidoscopy in colorectal cancer screening. *Scand J Gastroenterol* 2002;37:1103-7.
- Valori R, Rey J-F, Atkin WS, Bretthauer M, Senore C, Hoff G, et al. European guidelines for quality assurance in colorectal cancer screening and diagnosis. First edition-quality assurance in endoscopy in colorectal cancer screening and diagnosis. *Endoscopy* 2012;44(Suppl 3):SE88-105.
- Falchuk ZM, Griffin PH. A technique to facilitate colonoscopy in areas of severe diverticular disease. *N Engl J Med* 1984;310:598.
- Bak AW, Perini R, Schroeder T, Leung FW. Experience with water-aided colonoscopy in a Canadian community population. *J Interv Gastroenterol* 2013;3:49-52.
- Cadoni S, Leung FW. Water-assisted colonoscopy. *Curr Treat Options Gastroenterol* 2017;15:135-54.
- Cadoni S, Sauid I, Hassan C, Falt P, Fuccio L, Siau K, et al. Water-assisted colonoscopy-An International modified Delphi review on definitions and practice recommendations. *Gastrointest Endosc* 2021;93:1411-20.e18.
- Holl L, de Jonge V, van Leerdam ME, van Ballegooijen M, Looman CW, van Vuuren AJ, et al. Screening for colorectal cancer: Comparison of perceived test burden of guaiac-based faecal occult blood test, faecal immunochemical test and flexible sigmoidoscopy. *Eur J Cancer* 2010;46:2059-66.
- Atkin WS, Hart A, Edwards R, Cook CF, Wardle J, McIntyre P, et al. Single blind randomized trial of efficacy and acceptability of oral Picolax versus self administered phosphate enema in bowel preparation for flexible sigmoidoscopy screening. *BMJ* 2000;320:1504-9.
- Fracchia M, Senore C, Armaroli P, Ferraris R, Di Placido R, Musso A, et al. Assessment of the multiple components of the variability in the adenoma detection rate in sigmoidoscopy screening, and lessons for training. *Endoscopy* 2010;42:448-55.
- Segnan N, Senore C, Andreoni B, Aste H, Bonelli L, Crosta C, et al. Baseline findings of the Italian multicenter randomized controlled trial of "once-only sigmoidoscopy"<sup>2</sup>-SCORE. *J Natl Cancer Inst* 2002;94:1763-72.
- Hjermstad MJ, Fayers PM, Haugen DF, Caraceni A, Hanks GW, Loge JH, et al. Studies comparing numerical rating scales, verbal rating scales, and visual analogue scales for assessment of pain intensity in adults: A systematic literature review. *J Pain Symptom Manage* 2011;41:1073-93.
- Lai EJ, Calderwood AH, Doros G, Fix OK, Jacobson BC. The Boston Bowel preparation scale: A valid and reliable instrument for colonoscopy-oriented research. *Gastrointest Endosc* 2009;69:620-5.
- Lieberman DA, Williams LJ, Holub JL, Morris CD, Logan JR, Eisen GM, et al. Colonoscopy utilization and outcomes 2000 to 2011. *Gastrointest Endosc* 2014;80:133-43.
- Rex DK, Boland CR, Dominitz JA, Giardiello FM, Johnson DA, Kaltenbach T, et al. Colorectal cancer screening: Recommendations for physicians and patients from the U.S. multi-society task force on colorectal cancer. *Gastrointest Endosc* 2017;86:18-33.
- Holme Ø, Løberg M, Kalager M, Bretthauer M, Hernán MA, Aas E, et al. Effect of flexible sigmoidoscopy screening on colorectal cancer incidence and mortality: A randomized clinical trial. *JAMA* 2014;312:606-15.
- Atkin W, Wooldrage K, Parkin DM, Kralj-Hans I, MacRae E, Shah U, et al. Long term effects of once-only flexible sigmoidoscopy screening after 17 years of follow-up: The UK flexible sigmoidoscopy screening randomised controlled trial. *Lancet* 2017;389:1299-311.
- Rutter MD, Evans R, Hoare Z, Von Wagner C, Deane J, Esmaily S, et al. WASH multicentre randomised controlled trial: Water-assisted sigmoidoscopy in English NHS bowel scope screening. *Gut* 2021;70:845-52.
- Kirkøen B, Berstad P, Botteri E, Dalén E, Nilsen JA, Hoff G, et al. Acceptability of two colorectal cancer screening tests: Pain as a key determinant in sigmoidoscopy. *Endoscopy* 2017;49:1075-86.
- Senore C, Corrales L, Regge D, Hassan C, Iussich G, Silvani M, et al. Flexible sigmoidoscopy and CT colonography screening: Patients' experience with and factors for undergoing screening-insight from the proteus colon trial. *Radiology* 2018;286:873-83.
- Schoen RE, Wiessfeld JL, Bowen NJ, Switzer G, Baum A. Patient satisfaction with screening flexible sigmoidoscopy. *Arch Intern Med* 2000;160:1790-6.
- Senore C, Arrigoni A. Monitoring the performance of sigmoidoscopy screening: The need for a comprehensive approach. *Lancet Gastroenterol Hepatol* 2019;4:192-3.
- Hsieh YH, Tseng CW, Hu CT, Koo M, Leung FW. Prospective multicenter randomized controlled trial comparing adenoma detection rate in colonoscopy using water exchange, water immersion, and air insufflation. *Gastrointest Endosc* 2017;86:192-201.
- Fuccio L, Frazzoni L, Hassan C, La Marca M, Paci V, Smania V, et al. Water exchange colonoscopy increases adenoma detection rate: A systematic review with network meta-analysis of randomized controlled studies. *Gastrointest Endosc* 2018;88:589-97.
- Gidwani AL, Makar R, Garrett D, Gilliland R. A prospective randomized single-blind comparison of three methods of bowel preparation for outpatient flexible sigmoidoscopy. *Surg Endosc* 2007;21:945-9.
- Osgard E, Jackson JL, Strong J. A randomized trial comparing three methods of bowel preparation for flexible sigmoidoscopy. *Am J Gastroenterol* 1998;93:1126-30.
- Shaukat A, Rector TS, Church TR, Lederle FA, Kim AS, Rank JM, et al. Longer withdrawal time is associated with a reduced incidence of interval cancer after screening colonoscopy. *Gastroenterology* 2015;149:952-7.
- Bevan R, Blanks RG, Nickerson C, Saunders BP, Stebbing J, Tighe R, et al. Factors affecting adenoma detection rate in a national flexible sigmoidoscopy screening programme: A retrospective analysis. *Lancet Gastroenterol Hepatol* 2019;4:239-47.