

Effect of dynamic position changes on adenoma detection rate during colonoscope withdrawal: systematic review and meta-analysis



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ABSTRACT

Background and study aims The adenoma detection rate (ADR) is an important quality metric of colonoscopy. Higher ADR correlates with lower incidence of interval colorectal cancer. ADR is variable between endoscopists and depends upon the withdrawal technique amongst other factors. Dy-

dynamic position change (lateral rotation of patients with a view to keep the portion of the colon being inspected at a higher level) helps with luminal distension during the withdrawal phase. However, impact of this on ADR is not known in a pooled sample. We performed a systematic review and meta-analysis to study the impact of dynamic position changes during withdrawal phase of colonoscopy on ADR

Methods A comprehensive search of MEDLINE, EMBASE, Google Scholar, and the Cochrane Database was conducted from each database's inception to search for studies comparing dynamic position changes during colonoscopy withdrawal with static left lateral position (control). The primary outcome of interest was ADR. Other studied outcomes were polyp detection rate (PDR) and withdrawal time. Outcomes were reported as pooled odds ratio (OR) with 95% confidence intervals (CI) with statistical significance ($P < 0.05$). RevMan 5.3 software was used for statistical analysis.

Results Six studies were included in our analysis with 2860 patients. Of these, dynamic position change was implemented in 1177 patients while 1183 patients served as the controls. ADR was significantly higher in the dynamic position change group with pooled OR 1.36 (95% CI, 1.15–1.61; $P < 0.01$). There was low heterogeneity in inclusion studies ($I^2 = 0\%$). PDR was numerically higher in position change group (53.4% vs 49.6%) but not statistically significant ($P = 0.16$). Mean withdrawal time did not significantly change with dynamic position change (12.43 min vs 11.46 min, $P = 0.27$).

Conclusion Position change during the withdrawal phase of colonoscopy can increase the ADR compared to static left lateral position. This is an easy and practical technique that can be implemented to improve ADR.

Introduction

Colorectal cancer (CRC) is one of the most common malignancies in Western populations, including the United States. Colonoscopy is currently considered the gold standard method for diagnosis and removal of precancerous adenomatous polyps [1]. Current evidence points towards significant reduction in

the incidence of CRC and associated mortality with removal of adenomatous polyps [2, 3]. However, colonoscopy is far from perfect, with studies showing miss rates for both polyps and specifically adenomas ranging from 6% to 27% depending on size [4, 5]. The adenoma detection rate (ADR) of endoscopists has been shown to be inversely related to the development of interval CRC [6]. Therefore, ADR is considered an important

quality metric of colonoscopy and methods to improve it has been an active area of research. Amongst these are included good bowel prep, adequate withdrawal time, meticulous inspection technique, retroflexion in the right colon, and distal attachment devices to flatten the colonic folds.

The basic tenets of good inspection techniques include cleaning and suctioning residual liquid and solid debris, adequate luminal distension, and inspection behind folds [7, 8]. As opposed to distal attachment devices, meticulous inspection technique during withdrawal does not add extra cost to the procedure. Adequate luminal distension has been shown to improve visibility during colonoscope withdrawal [9]. Conventionally, colonoscopy is performed with the patient lying in the left lateral position. In this position the descending colon is dependent and therefore decompressed and retained fluid can also relocate to this segment making visualization less than optimal. Changing the patient position during the withdrawal phase can improve luminal distension. This concept originates from the experiences with barium enema and computed tomography (CT) colonography, where position change can promote adequate distension of the colon and the movement of excess fluid away from the area being observed [10]. The basic premise of position change is to bring the segment of colon being examined to the highest level, causing gas to rise to that area and fluid to move away to the dependent portion thereby resulting in adequate luminal distension. This can be achieved by having the patient in the left lateral position when examining the ascending colon, supine for transverse colon and in the right lateral position for the descending and sigmoid colon.

Currently, changing patient position during the withdrawal phase is not a routine practice. Reasons include time limitations, difficulty in moving sedated patients especially under deep sedation with propofol, and a lack of awareness regarding the potential benefits of position changes [11]. Previously it has been reported in randomized studies that there are benefits of changing patient position but the data have been conflicting [11–13]. We performed a systematic review and meta-analysis to examine the impact of dynamic patient position change during colonoscope withdrawal on adenoma detection rate (ADR) and polyp detection rate (PDR).

Methods

This systematic review and meta-analysis was performed according to the PRISMA guidelines [14]. The checklist is shown in ► **Table 1**.

Search strategy

An electronic search was performed in Pubmed (MEDLINE), EMBASE, Google Scholar, and the Cochrane Database. The search for studies of relevance was performed using the following search terms with corresponding Medical Subject Heading/Entree terms when appropriate: “colonoscopy”, “adenoma detection rate (ADR)”, “patient position” and/or “withdrawal”. Bibliography of eligible clinical study and review articles were manually searched. Two authors (V.N. and V.T.C) independently performed literature search and reviewed results. Duplicates

were removed and retrieved titles and abstracts were screened for their eligibility. ► **Fig. 1** shows the process of literature review, screening of articles, and exclusion and final selection of studies.

Eligibility

Only controlled studies where effect of position change (i. e. intervention) during colonoscopy was examined with outcome of ADR compared to no intervention. We excluded any study that did not compare position change arm to control arm, or did not report ADR, PDR, and withdrawal times. We excluded review articles, non-human studies, abstract form only and editorials. Studies where definition of intervention was not clearly defined.

Data extraction

Two investigators (V.N. and V.T.C.) independently reviewed the eligible studies and extracted data into a standardized format into MS Excel. Data extracted were patient demographics, year of publication, study location, number of subjects, bowel preparation quality, position changes of the patient, ADR, PDR and withdrawal times among both arms. Individual characteristics have been listed in ► **Table 2**.

Outcomes

The primary outcome of interest was ADR. Other studied outcomes were polyp detection rate (PDR) and withdrawal time, luminal distention score.

Statistical analysis

Pooled effect sizes for the meta-analyses were performed using Mantel–Haenszel method combining the effect sizes from different trials comparing position change and control arms. A fixed effects model was used as there is common effect in all studies and there is minimal/low heterogeneity ($I^2=0\%$) detected. Pooled odds ratio (OR) with corresponding 95% CI were calculated. Heterogeneity was calculated using I^2 test. Publication bias was assessed using funnel plot. The statistical analyses were performed using RevMan software (Review Manager version 5.3; The Nordic Cochrane Centre, Copenhagen, Denmark, The Cochrane Collaboration 2015).

Results

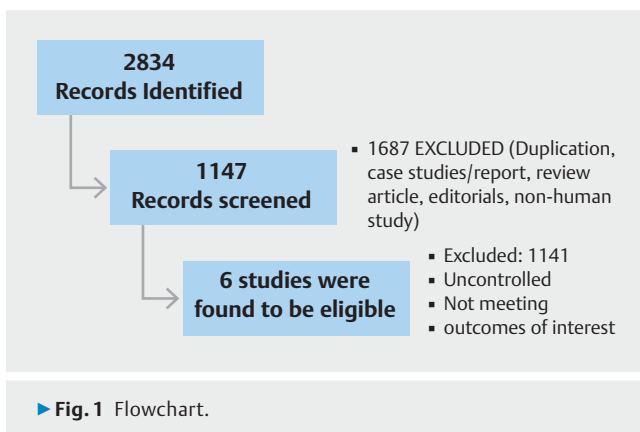
Of 2834 records reviewed, a total of six studies were found eligible with 2860 patients (981 males, reported in 4 studies). Of these, dynamic position change was implemented in 1177 patients while 1183 patients served as the controls. The included studies employing different strategies to assess the effect of position changes. East et al and Ball et al employed randomized crossover techniques, where each patient had the colon examined twice: one with position changes and the other where no position changes were employed [12, 15]. The remaining four studies employed randomization with 1:1 assignment for assessment of position changes [11, 13, 16, 17]. The study characteristics and Jadad score (which has been used for quality assessment) have been shown in ► **Table 2**.

► Table 1 PRISMA checklist.

Section/topic	#	Checklist item	Reported on page #
Title			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
Abstract			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	1
Introduction			
Rationale	3	Describe the rationale for the review in the context of what is already known.	2
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	2
Methods			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e. g., Web address), and, if available, provide registration information including registration number.	3
Eligibility criteria	6	Specify study characteristics (e. g., PICOS, length of follow-up) and report characteristics (e. g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	3
Information sources	7	Describe all information sources (e. g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	3
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	3
Study selection	9	State the process for selecting studies (i. e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	3
Data collection process	10	Describe method of data extraction from reports (e. g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	3
Data items	11	List and define all variables for which data were sought (e. g., PICOS, funding sources) and any assumptions and simplifications made.	3
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	5
Summary measures	13	State the principal summary measures (e. g., risk ratio, difference in means).	5
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e. g., I^2) for each meta-analysis.	5
Section/topic		Checklist item Reported on page #	
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e. g., publication bias, selective reporting within studies).	5
Additional analyses	16	Describe methods of additional analyses (e. g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	5
Results			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	5
Study characteristics	18	For each study, present characteristics for which data were extracted (e. g., study size, PICOS, follow-up period) and provide the citations.	5
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	5
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	5

► **Table 1** (Continuation)

Section/topic	#	Checklist item	Reported on page #
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	5
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	5
Additional analysis	23	Give results of additional analyses, if done (e. g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	5
Discussion			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e. g., healthcare providers, users, and policy makers).	5
Limitations	25	Discuss limitations at study and outcome level (e. g., risk of bias), and at review-level (e. g., incomplete retrieval of identified research, reporting bias).	6
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	6
Funding			
Funding	27	Describe sources of funding for the systematic review and other support (e. g., supply of data); role of funders for the systematic review.	None (1)



Adenoma detection rate

ADR was reported in all six studies. Pooled ADR was 41.63% (490/1177) in the dynamic position change group compared to 34.48% (408/1183) in the control group. ADR was significantly higher in the dynamic position change group with pooled OR 1.36 (95% CI, 1.15–1.61; $P < 0.01$) (► **Fig. 2**). There was low heterogeneity in included studies ($I^2 = 0\%$). The number needed to find one additional patient with at least one adenoma was 14.

When an analysis was performed for studies with Jadad score ≥ 3 , results did not change significantly. Pooled OR was 1.35 with 95% CI 1.13–1.62 in favor of the position change arm.

Polyp detection rate

PDR was reported in four studies. PDR was 53.35% (302/566) in the dynamic position change group compared to 49.65% (284/572). PDR was not significantly different between the 2

groups with a pooled OR = 1.32 (95% CI, 0.9–1.93; $P = 0.16$) (► **Fig. 3**). There was moderate heterogeneity in inclusion studies ($I^2 = 40\%$).

Withdrawal times

Withdrawal times were reported in a total of four studies in minutes. Mean withdrawal time in the dynamic position change group was 12.43 minutes vs 11.46 minutes in the standard group, $P = 0.27$. The withdrawal times included stoppage of clock for position changes and when interventions were performed, except for one study which used 6 minutes as withdrawal with 2 minutes per each section of the colon [9].

Luminal distention score

Two studies also reported correlation between luminal distension and ADR or PDR. One study showed ADR and PDR were positively correlated with an improved distension score (correlation coefficient, 0.12; $P < .001$) with other study showing no significant correlation between luminal distension and the number of polyps in the right side of the colon ($r = 0.03$; $P = 0.69$), the transverse colon ($r = -0.05$; $P = 0.47$) or the left side of the colon ($r = -0.05$; $P = 0.54$). ($r = 0.03$) [12, 15].

Publication bias

Funnel plot is shown in ► **Fig. 4**. There was no asymmetry suggestive of no significant publication bias.

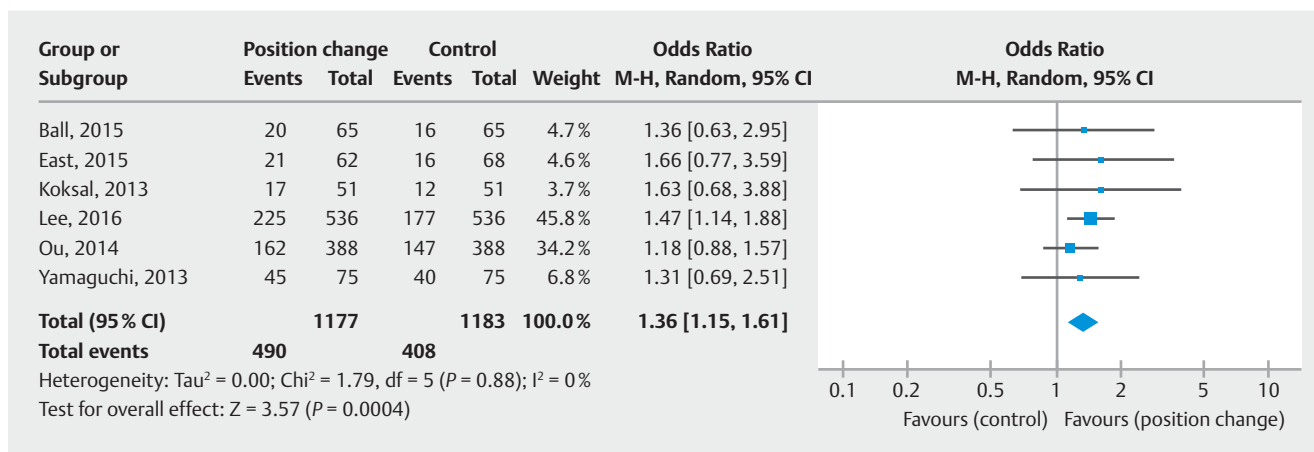
Discussion

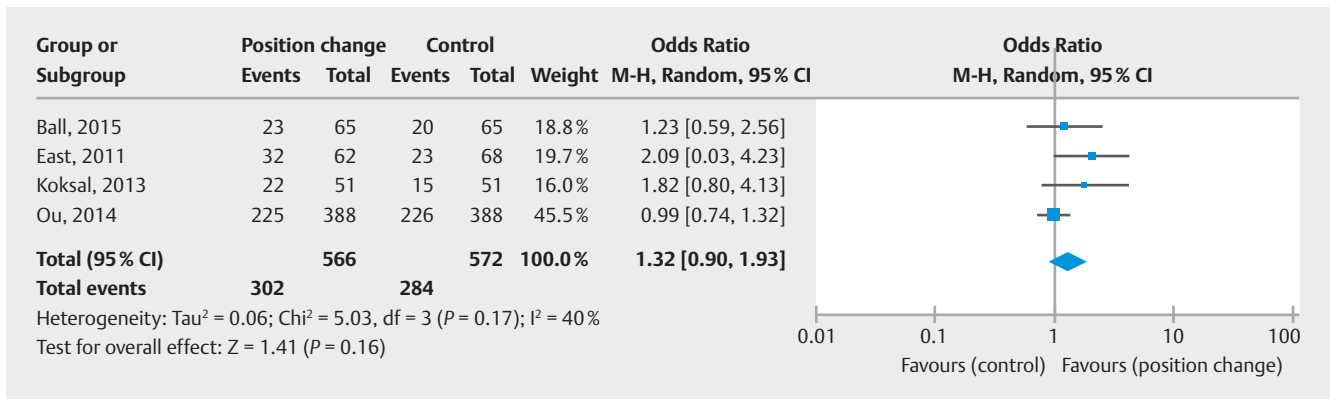
In this meta-analysis we show that the employment of dynamic position change during withdrawal phase of colonoscopy is associated with increased ADR. ADR is the main quality indicator of colonoscopy and it is inversely related to the incidence of

► **Table 2** Study characteristics, patient demographics.

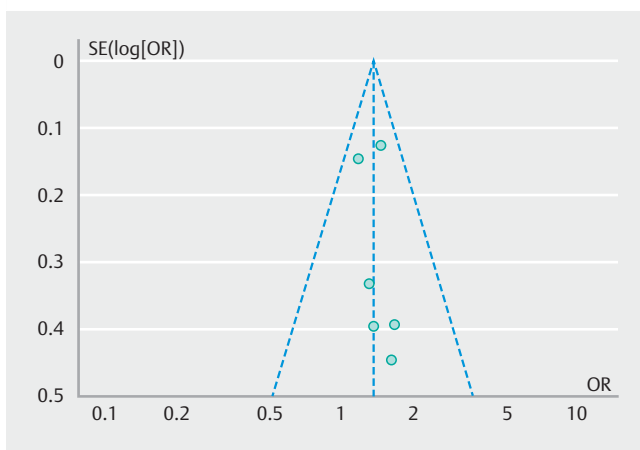
Study	Study design	Jadad score	Bowel preparation	Patients (male)	Regions of examination	Country	Position changes
East et al [12]	Randomized cross-over study	3	Good, Adequate	70	Cecum to descending colon	UK	Cecum, ascending colon, and hepatic flexure: left lateral position; transverse colon: supine position; splenic flexure and descending colon: right lateral position
Köksal et al [13]	Randomized cross-over study	2	NA	50	Cecum to sigmoid colon	Turkey	Cecum, ascending colon and hepatic flexure; transverse colon; and splenic flexure, descending colon and sigmoid colon. The first region was examined in the left lateral position twice. The second region was examined in the left lateral and supine positions. The third region was examined in the left lateral, right lateral and supine positions
Yamaguchi et al [17]	Randomized parallel-group study	2	NA	98	Cecum to rectum	Japan	Examination in the supine position was followed by either the following dynamic position changes (cecum to transverse colon, supine; splenic flexure and descending colon, right lateral; sigmoid colon, supine; and rectum, left lateral) or minimal position changes (cecum to sigmoid colon, supine; and rectum, left lateral)
Ball et al [15]	Randomized cross-over study	1	NA	130	Cecum to descending colon	UK	The position change was left lateral position for examination of the right side of the colon (cecum, ascending colon, and hepatic flexure) and right lateral position for examination of the left side of the colon (splenic flexure and descending colon but not including the sigmoid colon).
Ou et al [11]	Randomized parallel-group study	3	Fair, good and excellent	355	Ascending colon to rectum	Canada	Ascending colon/hepatic flexure examined in left lateral decubitus position, transverse colon in supine position, and splenic flexure/descending colon/sigmoid colon/rectum in right lateral decubitus position
Lee et al [16]	Randomized multicenter parallel-group study	3	Excellent, Good and Fair	506	Cecum to rectum	Korea	Cecum, ascending colon, and hepatic flexure: left lateral position; transverse colon: supine position; splenic flexure, descending colon, sigmoid colon, and rectum: right lateral position

NA, not available.

► **Fig. 2** Forest plot of ADR.



► Fig. 3 Forest plot of PDR.



► Fig. 4 Publication bias funnel plot.

interval cancer in patients [6]. Therefore, dynamic position change to bring the segment of the colon being examined to the highest position, thereby improving luminal distension and visualization is a simple and inexpensive means to improve the quality of colonoscopy. However, we did not find a statistical difference in two arms for PDR despite noting a higher PDR in intervention group compared to control group. This could be from several factors including but not limited to: small number of studies reporting PDR (n = 4), less significance of overall PDR (i.e. distal hyperplastic polyp), lack of information on diminutive and serrated polyps.

Several studies have explored the impact of dynamic position change on ADR and showed heterogeneous results. Crossover studies by East et al and Koksai et al noted an approximately 10% increase in ADR, which was significant with most prominent improvement in adenoma detection in the transverse colon in supine position [12, 13]. In the two-way crossover study by Ball et al, an improvement in luminal distension was observed in the right colon in the left lateral position and in the left colon in the right lateral position. They compared patients in dynamic position changes with patients who were supine only throughout the withdrawal phase [15]. However, the left side of the colon with the patient in the right lateral position

did not significantly increase the proportion of patients with ≥ 1 polyp and ≥ 1 adenoma compared with the supine position (7/130 [5.4%] vs 6/130 [4.6%], OR 1.2; $P=0.99$ and 4/130 [3.1] vs 4/130 [3.1], OR 1.0; $P=0.66$, respectively) [15]. In the study by Ou et al, a single-center, parallel-group study compared ADR with dynamic position changes to that in usual practice. In this study the control group had endoscopists perform the colonoscopies using their usual practices, which involved position changes as deemed necessary [11]. Dynamic position changes during colonoscope withdrawal did not improve the ADR (41.8 vs. 37.9%, $P=0.28$). [11] In the study by Lee et al, a large-scale, multicenter, randomized, and parallel-group design showed that ADR was higher in the position change group than in the control group (42.4 vs. 33.0%, $P=0.002$). The authors further reported significantly higher detection of adenomas in the transverse colon and left colon [16]. Studies from East et al and Ball et al, also reported a correlation between luminal distension and ADR or PDR. One study showed that ADR and PDR were positively correlated with an improved distension score (correlation coefficient, 0.12; $P<.001$) and another study showed no significant correlation between luminal distension and polyp detection in the right side of the colon [12, 15].

The three basic components of good withdrawal technique are adequate luminal distension, cleaning and suctioning fluid and solid debris, and inspection behind the folds. Position changes during the withdrawal phase are one of the simplest maneuvers that can be employed for enhancing luminal distension given natural rise of air/CO₂ to highest position [18]. Adequate luminal distension is imperative for good visualization for adenoma detection. Furthermore, position change also shifts fluid away from the area of interest and opens the angles at flexures [10, 19]. Although other methods such as prolonged insufflation may achieve adequate colonic luminal distension, they may not necessarily achieve the same increase in ADR as position changes [12]. In addition, it is often difficult to distend the segment of colon that is in the dependent position in spite of our best attempts at insufflation. Another word of caution with respect to aggressive insufflation is post-procedural abdominal discomfort. Although dynamic position of a sedated patient may take some time and effort thereby increase the

duration of the procedure, this may be offset by less time required for insufflating and suctioning fluid. Furthermore, faster dispositions and discharge from the recovery unit may be possible stemming from decreased gaseous distension after the procedure [9]. However, these remain to be systematically evaluated and proven.

Our meta-analysis has some limitations. The number of studies that could be included was relatively small, but the study population was very diverse with studies being performed in Asia, North America, and Europe. This improves the generalizability of the results. Furthermore, we have more studies included than the previous network meta-analysis [20]. The goal of the prior study was comparison of all available modalities including any electronic chromoendoscopy techniques and modification of colonoscopy techniques for ADR. For separate analysis of position change, only one study was included due to their criteria. In comparison, our study is most current systematic review and meta-analysis on dynamic position change and its impact on ADR. Due to the obvious lack of blinding of the endoscopists, that is unavoidable in these types of studies, investigator bias is possible. This may lead to a more meticulous exam performed in those patients in the dynamic position change arm. The experience/skill of endoscopists in the different studies also varied widely and could not be accounted for with respect to the impact on ADR. The ADR increase with dynamic position change is modest, which would therefore have an even lower impact on the incidence of interval cancer. We also understand our analysis is largely driven by two studies, Lee et al and Ou et al. As Ou et al. had turning in the control arm in 45% of patients resulting in some dilution of the "control" aspect in pooled estimate, we performed an analysis excluding this study. Our results for ADR with position change remained unchanged with pooled OR 1.46 (1.19–1.80; $P < 0.01$). There is also a lack of information regarding adhesions and diverticulosis, sedation requirements for elderly and their effects on colon segment examination. We also realize the limitation of dynamic positioning in certain patient populations (obese, critically ill, sleep apnea). Furthermore, there was a lack of detailed information regarding bowel preparation and withdrawal times (position changes included) in some studies or the effect of position change on advanced adenomas. It is also not clear from the studies whether the reported withdrawal time included the time needed to change the position of the patient that could be substantial especially with deep sedation. No details regarding post procedural discomfort and recovery was available in the studies either.

There have been other methods described to improve mucosal inspection especially the areas on the proximal aspects of folds. Distal attachments like the cap, Endorings, and Endocuff that flatten the folds have shown to improve ADR but come with an additional and not negligible cost. These distal attachment devices not only add to the cost of colonoscopy but offer only a modest improvement in ADR as was shown in a recent network meta-analysis [21]. Retroflexion of the colonoscope is also a simple and effective technique to improve ADR but is limited to the right colon. In contrast, dynamic position change can be effective for all segments of the colon and entails no ex-

tra cost and thereby is an inexpensive and effective means to improve ADR. Many of the studies in this area come from the UK, where unsedated/low-level sedation colonoscopy is much more prevalent than in the United States. Turning patients who are under deep sedation with propofol would be more problematic and labor-intensive, and this appears to be the only perceivable drawback of dynamic position change.

Conclusion

In conclusion, this meta-analysis shows that dynamic position change during the withdrawal phase of colonoscopy is associated with increased ADR. We suggest left lateral position for right colon, supine positioning for transverse, and right lateral position for left side of the colon during withdrawal. This is a simple, safe, and inexpensive method that can be easily employed in routine clinical practice to improve the quality of colonoscopy.

Competing interests

The authors declare that they have no conflict of interest.

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