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ORIGINAL ARTICLE

Retrospective Study

Colonoscopy procedural volume increases adenoma and polyp detection rates in gastroenterology trainees

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Abstract

AIM

To investigate changes in polyp detection throughout fellowship training, and estimate colonoscopy volume required to achieve the adenoma detection rate (ADRs) and polyp detection rate (PDRs) of attending gastroenterologists.

METHODS

We reviewed colonoscopies from July 1, 2009 to June 30, 2014. Fellows' procedural logs were used to retrieve colonoscopy procedural volumes, and these were treated as the time variable. Findings from screening colonoscopies were used to calculate colonoscopy outcomes for each fellow for the prior 50 colonoscopies at each time

point. ADR and PDR were plotted against colonoscopy procedural volumes to produce individual longitudinal graphs. Repeated measures linear mixed effects models were used to study the change of ADR and PDR with increasing procedural volume.

RESULTS

During the study period, 12 fellows completed full three years of training and were included in the analysis. The average ADR and PDR were, respectively, 31.5% and 41.9% for all fellows, and 28.9% and 38.2% for attendings alone. There was a statistically significant increase in ADR with increasing procedural volume (1.8%/100 colonoscopies, P = 0.002). Similarly, PDR increased 2.8%/100 colonoscopies (P = 0.0001), while there was no significant change in advanced ADR (0.04%/100 colonoscopies, P = 0.92). The ADR increase was limited to the right side of the colon, while the PDR increased in both the right and left colon. The adenoma per colon and polyp per colon also increased throughout training. Fellows reached the attendings' ADR and PDR after 265 and 292 colonoscopies, respectively.

CONCLUSION

We found that the ADR and PDR increase with increasing colonoscopy volume throughout fellowship. Our findings support recent recommendations of ⩾ 275 colonoscopies for colonoscopy credentialing.

Key words: Screening colonoscopy; Colorectal cancer; Polyp detection rate; Colonoscopy volumes; Adenoma detection rate; Gastroenterology training

Core tip: Adenoma and polyp detection rates are important colonoscopy quality indicators. Competence in colonoscopy is measured by motor skills and not adenoma detection rate (ADR) and polyp detection rate (PDR). Recent guidelines recommend at least 275 colonoscopies to achieve competence. In this study, we found that ADR, PDR, adenoma per colon, and polyp per colon significantly increase throughout fellowship training. Fellows achieve the ADR and PDR of attendings after 262 and 292 colonoscopies. The variability of polyp detection among fellows suggests that ADR and PDR could be used during fellowship as part of periodic feedback.

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INTRODUCTION

Colorectal cancer (CRC) is the third most common cancer and second leading cause of cancer deaths in the United States[1]. Colonoscopy is the preferred modality for screening for colon cancer[2], and an essential follow-up procedure when other screening tests are positive. Several studies found that colonoscopy and polypectomy decrease colon cancer-specific mortality[3-5]. However, this is dependent on the quality of colonoscopy, and the ability of the endoscopist to detect and remove precancerous polyps. The adenoma detection rate (ADR), the most important quality indicator of colonoscopy, was found to be inversely associated with risk for interval colon cancer[6,7]. Most interval cancers are related to missed lesions during a screening colonoscopy[8]. Current practice guidelines include a recommendation for a minimum ADR of 20% in women and 30% in men to ensure adequate colonoscopy quality[9]. During gastroenterology training, competency in colonoscopy has been traditionally measured by the ability of the trainee to achieve cecal intubation in a timely manner (< 15 min) and resect polyps independently. The current Accreditation Council for Graduate Medical Education (ACGME) guidelines include a recommendation that fellows perform at least 140 colonoscopies during training to achieve competence. However, previous studies found that the number of procedures needed to achieve competence is much higher (275-500)[10-13]. Furthermore, polyp and adenoma detection, which is an essential goal of colonoscopy, is not part of competency assessment. Therefore, it is important to examine the change in adenoma and polyp detection as fellows increase their colonoscopy volume, and determine the number of colonoscopies that allows fellows to achieve an adequate polyp and adenoma detection rate.

In a retrospective study, it was found that the ADR was higher among third year fellows than among first and second year fellows[14]. Other studies found no change in adenoma and polyp detection with increasing fellowship training level[15,16]. In a prospective tandem colonoscopy study it was found that fellows with a higher colonoscopy volume had lower adenoma miss rates (AMR), and it was estimated that 450 colonoscopies would be required to achieve an AMR of < 25%[17]. In a retrospective study in which trainees were followed throughout their fellowship training, it was found that fellows' ADRs and polyp detection rates (PDR) improved when the fellows had conducted > 140 colonoscopies[18]. There are several limitations to these studies, including the small number of procedures performed by the fellows, inclusion of non-screening colonoscopies in calculating the ADR, and including fellows from various stages of training during only a limited part of their fellowship. In addition, none of these studies examined the change in individual fellow's ADRs and other colonoscopy metrics throughout fellowship training.

Our primary aim for the present study was to evaluate changes in the ADR, PDR, and advanced ADR with increasing colonoscopy procedural volume among gastroenterology trainees. Our secondary aims were to investigate changes in other colonoscopy metrics, such as adenoma per colon, polyp per colon, and left *vs* right-

sided detection rates. We also aimed to estimate the number of procedures required for fellows to achieve the ADRs and PDRs of attending gastroenterologists. This was done by examining a large sample of screening colonoscopies performed by 12 gastroenterology trainees throughout their complete three-year fellowship, using a longitudinal analysis method that accounts for the individual and combined trajectories of change in outcome with increasing procedural volume.

MATERIALS AND METHODS

Data source and database creation

For this retrospective study, which was approved by the Emory University Institutional Review Board, we used the endoscopic procedure database at Grady Memorial Hospital in Atlanta, Georgia. Informed consent was waived by the Institutional Review Board due to the large sample size, retrospective study design, and the fact that this study does not affect the welfare of the patients. Information about all endoscopic procedures performed in the gastroenterology endoscopy unit is prospectively collected and entered into the database, and includes variables such as procedure type, patient's medical record number, age, race, procedure indication, endoscopist, and fellow participation in the procedure. We reviewed screening colonoscopies for patients aged 40-85 performed by gastroenterology fellows who completed their entire gastroenterology training between July 1, 2009 and June 30, 2014. Gastroenterology trainees in the training program rotate through three different sites: Grady Memorial Hospital, Veterans Affairs Medical Center, and Emory University Hospital. However, all screening colonoscopies are performed at Grady Memorial hospital. For each training fellow we created a separate Microsoft Excel dataset that included all of his or her screening colonoscopies performed at Grady throughout their fellowship training. This included the patient's age, race (black or non-black), and sex; colon preparation ("prep") quality (good, fair-adequate, fair-inadequate, poor) and success at cecal intubation; and polyp size (1-5 mm, 6-9 mm, ⩾ 9 mm), number, location, and histology. Procedures with unsuccessful cecal intubation, fair-inadequate prep or poor prep were considered "inadequate" procedures, while those with successful cecal intubation in addition to fair-adequate or good prep were considered "adequate" procedures. Polyp location was categorized as right colon (cecum, ascending colon, hepatic flexure, and transverse colon) and left colon (splenic flexure, descending colon, sigmoid, and rectum). Adenomatous polyps were categorized as advanced and non-advanced adenomas. Advanced adenomas included adenomas larger than 9 mm in size and those that had histologic features of tubulovillous/villous structure, high-grade dysplasia, or adenocarcinoma.

We then sorted the colonoscopies in ascending temporal order, starting with the first day a screening colonoscopy was performed and continuing until the last screening colonoscopy was performed during fellowship. Next, we reviewed the fellow's procedure logs that contained the total number of colonoscopies (for all indications) performed at all training locations. Using this information, we assigned a procedure number that reflected the "rank" of each screening colonoscopy for that fellow. In assigning the rank, all colonoscopies performed by fellows for screening, polyp surveillance, and diagnostic indications at all locations contributed to the procedural volume. However, only screening colonoscopies were included in the analysis to calculate procedural outcomes. Patients with a personal history of colon cancer or prior colonic surgery were excluded from analysis. Procedural outcomes were defined as follows: Adenoma detection rate (ADR) - the percentage of screening colonoscopies with at least one histologically proven adenoma; polyp detection rate (PDR) - the percentage of screening colonoscopies with at least one polyp removed during the colonoscopy; and advanced ADR - the percentage of screening colonoscopies with at least one advanced adenoma (see above). The mean number of adenoma per colon (APC) was calculated by dividing the total number of adenomas by the number of screening colonoscopies performed. The mean number of polyps per colon (PPC) was calculated by dividing the total number of polyps by the number of screening colonoscopies performed.

Starting at the 50th screening colonoscopy, we calculated procedural outcomes for the current colonoscopy and the previous 49 colonoscopies (50 procedures for each outcome measurement). We also calculated the mean age and the percentage of patients in this block of 50 procedures who were male, black, and had an adequate exam. With each additional screening colonoscopy, these outcomes and control variables were recalculated until the last screening colonoscopy in the dataset was reached. The final dataset contained observations organized in ascending order by colonoscopy procedure rank number. Each ranked observation, starting at the 50th screening colonoscopy, contained colonoscopy outcome measures and time varying percentages as mentioned above. This process was conducted for each of the 12 fellows. Finally, we merged the 12 individual spreadsheets into one longitudinal dataset that contained the fellows' ID code, the procedural rank variable, time varying outcomes (ADR, PDR, APC, PPC), and time varying control variables (percentage of male patients, black patients, procedures with inadequate prep, and mean age).

To obtain a reference standard to which to compare the fellow's performance, we reviewed all screening colonoscopies performed by the attending physicians alone without the involvement of fellows at Grady Memorial Hospital. We used the same inclusion and exclusion criteria mentioned above for the fellows' procedures. The demographic characteristics of the patients who underwent screening colonoscopies were similar to those of the patients included in the calculation of outcomes for the fellows' procedures. We calculated the ADR, PDR, APC, and PPC for the attending-alone

group. These values were used as target levels to estimate the number of procedures it takes for fellows to achieve attendings' level of polyp detection.

Screening colonoscopy information

At our hospital, patients are referred for screening colonoscopy by their primary care physician or their gastroenterologist. For bowel preparation, patients received 4 L of polyethylene glycol solution as a single dose regimen the evening before the procedure. All procedures were performed with moderate sedation. During the study period, there were 8 attendings who supervised the 12 fellows who performed the colonoscopies. The fellow began the procedure and attempted insertion of the colonoscope to the cecum. The attending physician assisted when there was difficulty passing an area of the colon. The attending usually returned the scope to the fellow once the problematic area of the colon was traversed, though this varied per procedure, attending, and fellow level of training. The attending physicians were present and monitored fellows throughout the duration of the procedure. In the attending-alone group, the attending started and completed the procedure with no fellow involvement.

Statistical analysis

All analyses were conducted using SAS version 9.4 (SAS Institute Inc., Cary, NC, United States) statistical software. Descriptive statistics, including means, ranges, and frequencies, were used to characterize the study population. For each fellow, from their measurement time points, we calculated ranges and mean values for each predictor and outcome. We constructed individual and combined graphs to illustrate the change in colonoscopy outcome with increasing colonoscopy procedural volume, which was used as a proxy measure of the time variable. To examine the individual and combined trajectories of all fellows, defined as change in colonoscopy outcome with increasing colonoscopy volume, we used repeated measures linear mixed effects longitudinal models. The unconditional growth model to investigate the individual fellows' trajectories included the outcome and procedural volume (main exposure), and accounted for the random effect of the intercept with an unstructured covariance matrix. For the combined trajectories, the models included the outcome and procedural volume (main exposure), and mean age, percentages of black patients, sex, and inadequate prep as time-varying predictors, and accounted for the random effect of the intercept and procedural volume with an unstructured covariance matrix. The time varying predictors were centered to their mean, and the procedural volume was centered to procedure $n = 50$ to ease the interpretation of the initial status. The unconditional means model was used to calculate the mean outcome for the entire cohort. This included the outcome in the model statement and accounted for the variable effect of the intercept. The results are reported as the estimated means and 95%CIs. A P-value $\leqslant 0.05$ (two-sided) was used to assess statistical significance. We used the results of the longitudinal growth model (initial status and rate of change) to estimate the number of colonoscopies required to achieve the attending-alone group mean ADR, PDR, APC, and PPC.

RESULTS

Between July 1, 2009 and June 30, 2014, 12 fellows completed their full three-year clinical fellowship training. A total of 3123 screening colonoscopies performed by these fellows were included in the analysis. The attending physicians performed 2174 procedures without fellow involvement. The characteristics of the screening colonoscopies performed by the fellows and the attendings alone are summarized in Table 1. The overall mean ADR, PDR, and advanced ADR for all fellows were 31.5%, 41.9%, and 7.8%, respectively. There was substantial inter- and intra-individual variation in the ADR, PDR, and advanced ADR. The mean ADR ranged from 21.6% to 39.8%, and ADR values ranged from 8% to 52% throughout all measurement time points. The mean PDR ranged from 32.5% to 53.8%, while PDR values ranged from 14% to 70%. The overall ADR and PDR of the attending-alone group during the study period were 28.9% and 38.2%, respectively.

Primary outcomes

Plots of individual and combined fellows' ADR, PDR, and advanced ADR are shown in Figure 1. There was a statistically significant increase in the ADR among all fellows (1.8% per 100 colonoscopies, $P = 0.002$) (Figure 1A). Similarly, there was a statistically significant increase in the PDR among all fellows (2.8% per 100 colonoscopies, $P = 0.0001$) (Figure 1B). Overall, there was no substantial or statistically significant change in the advanced ADR with increasing procedural volume (0.04% per 100 colonoscopies, $P = 0.92$) (Figure 1C).

Secondary outcomes

In addition to increasing ADR and PDR, the adenoma per colon (APC) and polyp per colon (PPC) also increased with increasing procedural volume (Figure 2A and B, and Table 2). The mean APC for the entire cohort was 0.58, and it increased by 0.05 per 100 colonoscopies, ($P = 0.0001$). The mean PPC was 0.84, and there was positive trend of 0.09 per 100 colonoscopies for this metric ($P < 0.0001$). However, there was a difference in the trends for detecting polyps in the right *vs* the left colon. The right-side ADR (ADR-right) increased with increasing procedural volume (1.9% per 100 colonoscopies, $P = 0.006$), while the left-side ADR (ADR-left) increased slightly (0.6% per 100 colonoscopies, $P = 0.05$) (Figure 2C and D). This was also observed for the APC, for which where APC-right

Table 1 Characteristics of screening colonoscopies performed by 12 gastroenterology fellows throughout their 3 years of clinical training (n = 3123), and 8 attendings alone (n = 2174), July 1 2009 to June 30 2014

Fellow	Number of screening colonoscopies	Total colonoscopy procedure volume	Patient's mean age (yr)	Male patients (%)	Black patients (%)	Adequate exam (%)	Mean ADR (%)	Mean PDR (%)	Mean advanced ADR (%)
A	326	751	58.5	39.4	86.3	90.5	31.0	38.1	6.9
B	277	702	58.2	36.3	83.1	91.9	28.4	34.9	9.1
C	282	680	57.8	39.1	88.7	90.8	28.8	42.4	6.7
D	328	668	58.4	35.4	87.1	92.8	31.2	37.5	10.7
E	214	566	57.8	35.4	89.2	92.6	35.7	53.8	8.9
F	275	546	57.9	37.7	86.1	93.1	32.7	47.8	6.7
G	254	561	58.4	41.2	87.7	85.3	21.6	32.5	8.6
H	226	689	58.0	35.9	90.4	81.1	31.5	41.2	6.5
I	229	600	57.0	37.9	85.2	89.4	34.6	41.8	7.5
J	206	586	58.0	35.2	90.8	91.7	28.2	36.5	4.8
K	244	549	58.2	36.5	84.0	91.8	34.5	44.8	5.7
L	261	569	58.6	35.7	90.5	91.7	39.8	51.5	12.0
All fellows	3123	7467	58.1	37.2	87.3	89.8	31.5	41.9	7.8
Attendings alone	2174		57.9	36.3	89.3	90.1	28.9	38.2	8.5

Adequate colonoscopies were those in which the cecum was reached and the preparation quality was either good or fair-adequate. ADR: Adenoma detection rate; PDR: Polyp detection rate.

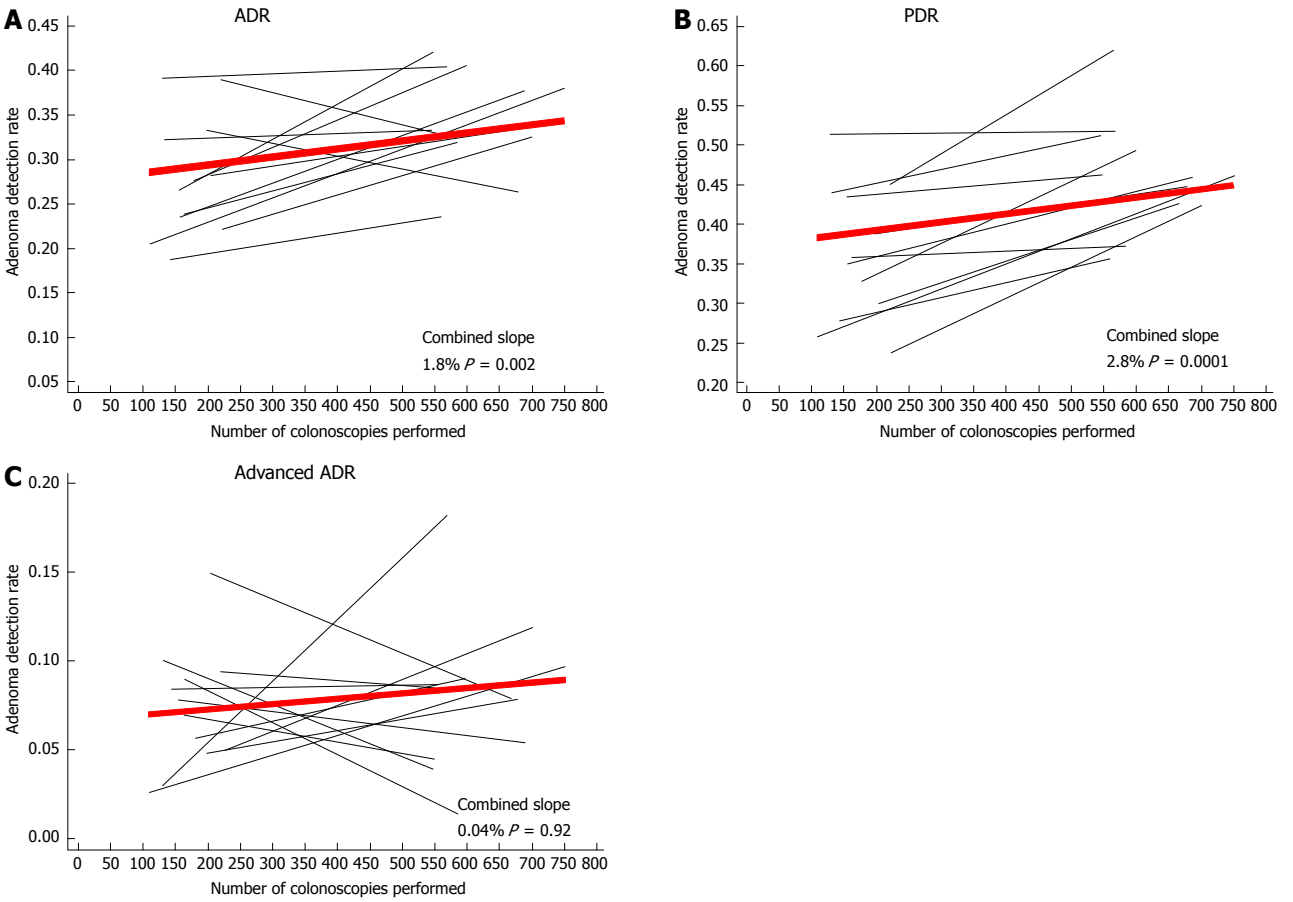
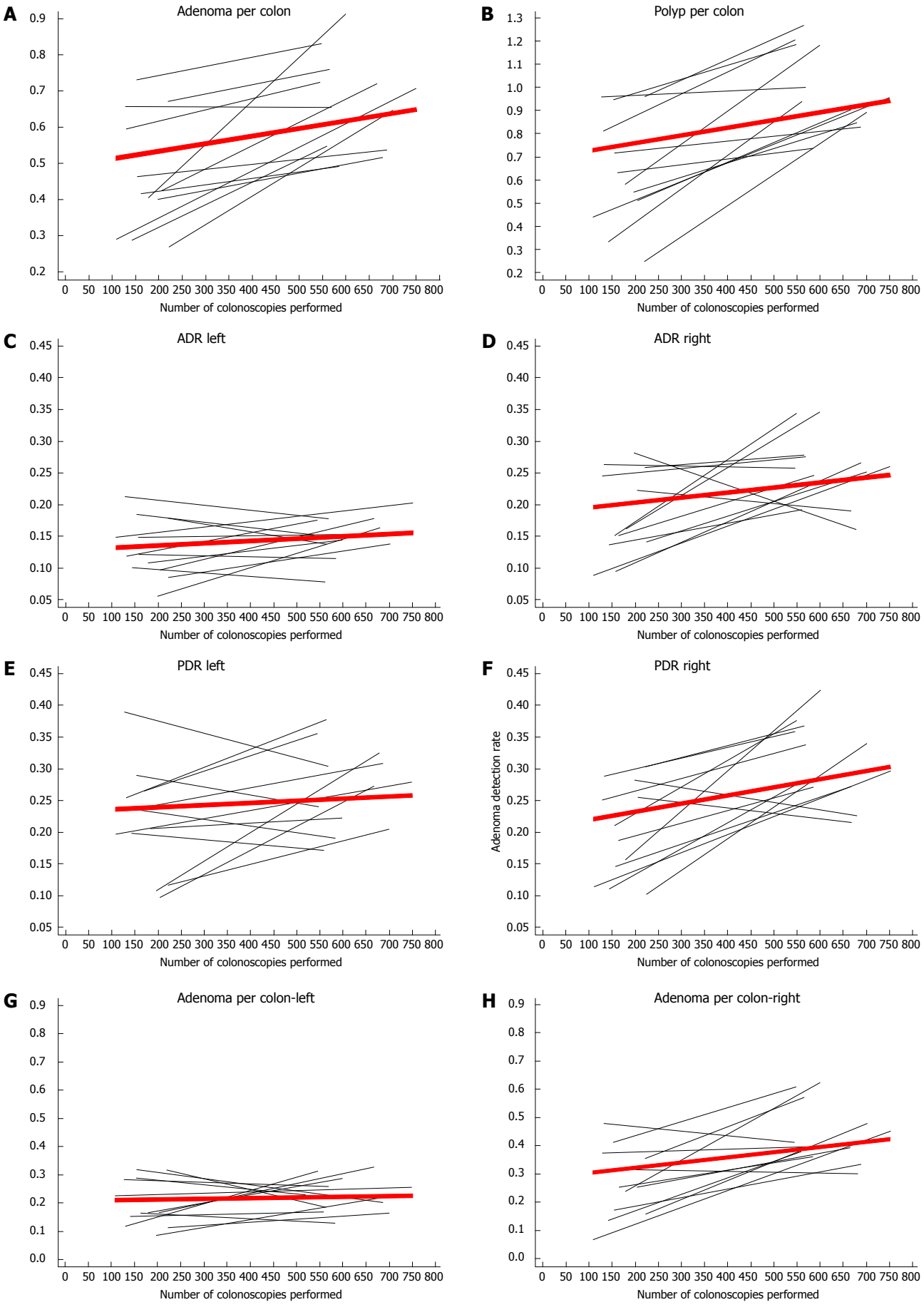


Figure 1 Individual and combined change trajectories of adenoma detection rate, polyp detection rate, and advanced adenoma detection rate for 12 fellows throughout their fellowship training. A: ADR per rank; B: PDR; C: Advanced ADR. The black lines represent individual fellows and the red line represents the mean for the entire group of fellows. The numbers in the bottom right corner of each panel represent the slope (absolute percentage increase in outcome per 100 screening colonoscopies) and its associated P value. Models included the outcome, procedural volume (main exposure), and mean age, percentages of black patients, sex, and inadequate prep as time-varying predictors. ADR: Adenoma detection rate; PDR: Polyp detection rate.

increased by 0.04 per 100 colonoscopies, P = 0.001; while the estimated increase in APC-left was only 0.01 per 100 colonoscopies and not statistically significant (P = 0.24) (Figure 2G and 2H). The PDR and PPC for both


A
Adenoma per colon
B
Polyp per colon
C
ADR left
D
ADR right
E
PDR left
F
PDR right
G
Adenoma per colon-left
H
Adenoma per colon-right
Adenoma detection rate
Number of colonoscopies performed
0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800

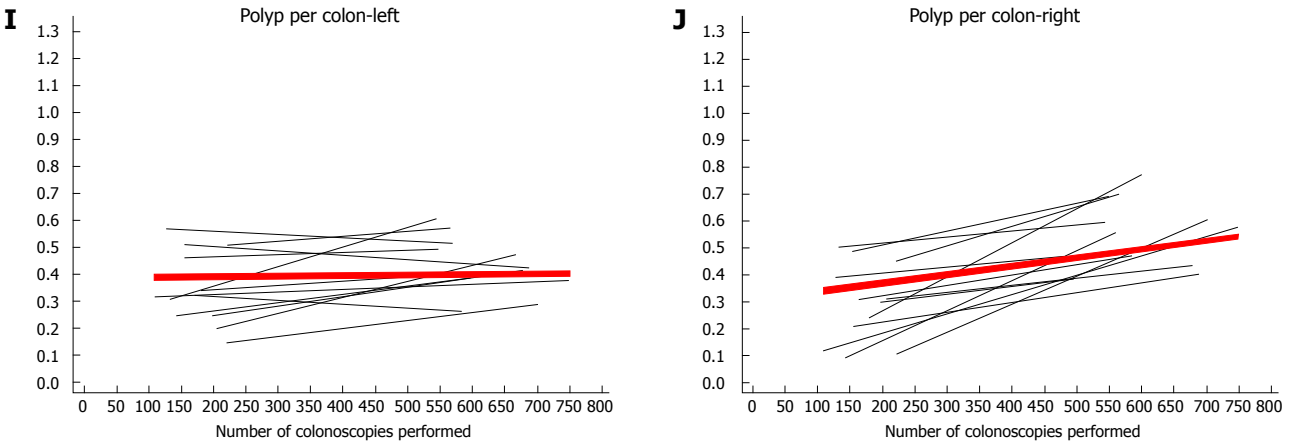


Figure 2 Individual and combined change trajectories colonoscopy metrics. A: Adenoma per colon (APC); B: Polyp per colon (PPC); C: Left-sided Adenoma detection rate (ADR); D: Right-sided ADR; E: Left sided polyp detection rate (PDR); F: Right-sided PDR; G: Left-sided APC; H: Right-sided APC; I: Left-sided PPC; J: Right-sided PPC.

Table 2 Adjusted mean polyp-related outcomes, estimated initial status, and changes in outcomes per 100 screening colonoscopies[1] among the entire group of fellows (n = 12)

Outcome[1]	Overall mean[2] (95%CI)	Mean after first 50 colonoscopies (95%CI)	Change in outcome per 100 colonoscopies (95%CI)	P value[3]	Number of procedures to achieve mean attending value[4]
ADR (%)	31.5 (28.7-34.3)	25.1 (21.1-29.2)	1.8 (0.8-2.7)	0.002	265
ADR-right (%)	22.3 (20.1-24.4)	15.3 (10.6-20.0)	1.9 (0.7-3.2)	0.01	
ADR-left (%)	14.2 (12.4-16.0)	11.6 (8.3-14.9)	0.6 (0.001-1.3)	0.05	
PDR (%)	41.9 (37.9-45.9)	31.4 (26.7-36.0)	2.8 (1.7-3.9)	0.0001	292
PDR-right (%)	26.5 (23.8-29.2)	16.0 (10.6-21.4)	2.9 (1.5-4.3)	0.001	
PDR-left (%)	24.9 (21.5-28.3)	18.7 (13.1-24.3)	1.6 (0.3-2.9)	0.02	
AADR (%)	7.8 (6.6-9.1)	7.4 (4.6-10.2)	0.04 (-0.80-0.90)	0.92	
APC	0.58 (0.52-0.65)	0.39 (0.28-0.49)	0.05 (0.03-0.07)	0.0001	399
APC-right	0.37 (0.32-0.42)	0.20 (0.12-0.28)	0.04 (0.02-0.06)	0.001	
APC-left	0.22 (0.19-0.25)	0.18 (0.11-0.26)	0.01 (-0.01-0.02)	0.24	
PPC	0.84 (0.74-0.94)	0.51(0.36-0.66)	0.09 (0.06-0.12)	< 0.0001	375
PPC-right	0.45 (0.39-0.50)	0.21 (0.11-0.31)	0.06 (0.04-0.09)	< 0.0001	
PPC-left	0.40 (0.34-0.46)	0.30 (0.21-0.39)	0.03 (0.01-0.05)	0.01	

[1]From linear mixed effects regression models, controlling for age, sex, race, and inadequate procedure; [2]Mean from all screening colonoscopies over all 3 years of training; [3]P value associated with the rate of change; [4]Mean attending values were: ADR 28.9%, PDR 38.2%, APC 0.57, and PPC 0.80. ADR: Adenoma detection rate; PDR: Polyp detection rate; AADR: Advanced ADR; APC: Mean adenoma per colon; PPC: Mean polyp per colon. Right colon included the cecum, ascending colon, hepatic flexure, and transverse colon. Left colon included splenic flexure, descending colon, sigmoid, and rectum.

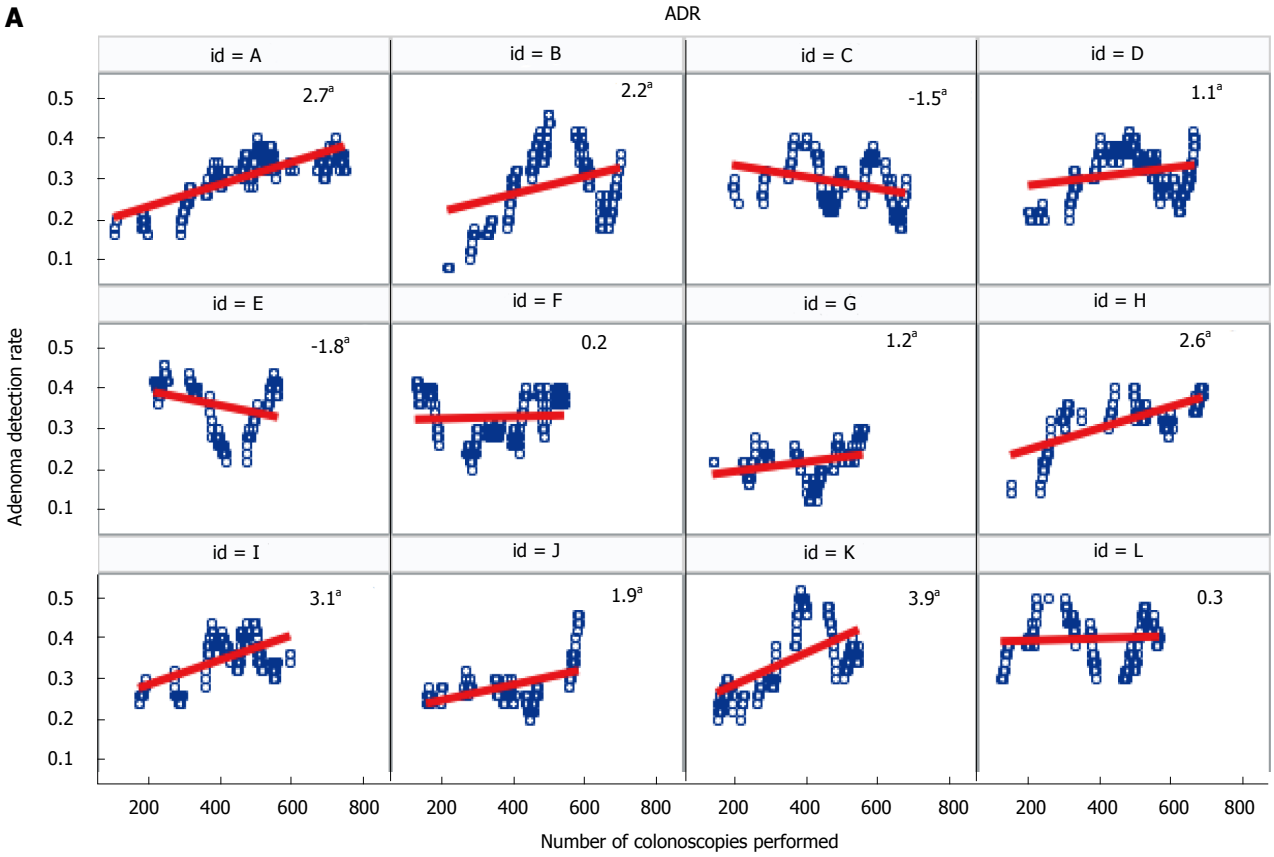
sides of the colon increased with increasing procedural volume; however, the increase in PDR-right was higher than PDR-left (2.9%, P = 0.0001 *vs* 1.6%, P = 0.02, respectively), and the increase in PPC-right was higher than PPC left (0.06, P < 0.0001 *vs* 0.03, P = 0.01) (Figure 2E, F, I, J). In the attending-alone group, the overall APC and PPC were 0.58 and 0.8, respectively.

The numbers of colonoscopies required to achieve the outcomes (ADR, PDR, APC, and PPC) of those of attendings estimated using the results of longitudinal analysis are shown in Table 2. Overall, on average, fellows achieved the attendings' level of ADR and PDR after 265 and 292 colonoscopies, respectively. The corresponding numbers for the APC and PPC were 399 and 375.

Changes in the trajectories of the ADR, PDR, and advanced ADR for individual fellows throughout their fellowship training are shown in Figure 3. The ADR for most fellows statistically significantly increased with increasing procedural volume. The ADR for eight fellows increased, while for two fellows it remained the same, and for two it decreased (Figure 3A). Similarly, the PDR for nine fellows statistically significantly increased, whereas for three fellows it remained relatively stable (Figure 3B). The trends for change in the advanced ADR were variable among fellows; some fellows had increasing rates, some had decreasing rates, and others remained stable (Figure 3C).

DISCUSSION

Our results indicate that there are clinically important increases in the ADR, PDR, APC, and PPC as gastroenterology fellows increase their colonoscopy procedural volume. This strongly suggests that polyp detection is a learned skill that improves as fellows perform more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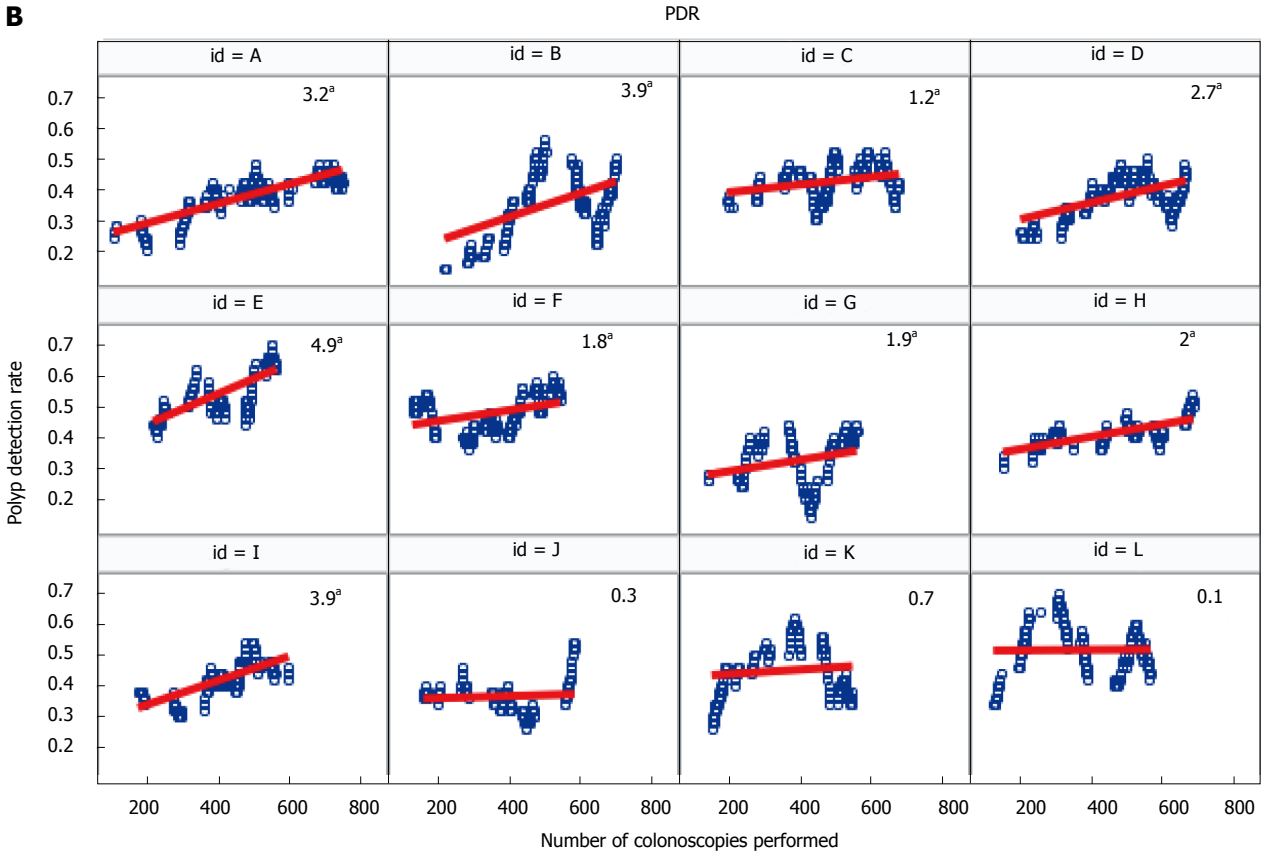
Adenoma detection rate
Number of colonoscopies performed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3.9a
1.2a
2.7a
4.9a
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1.9a
2a
3.9a
0.3
0.7
0.1
Polyp detection rate
Number of colonoscopies performed

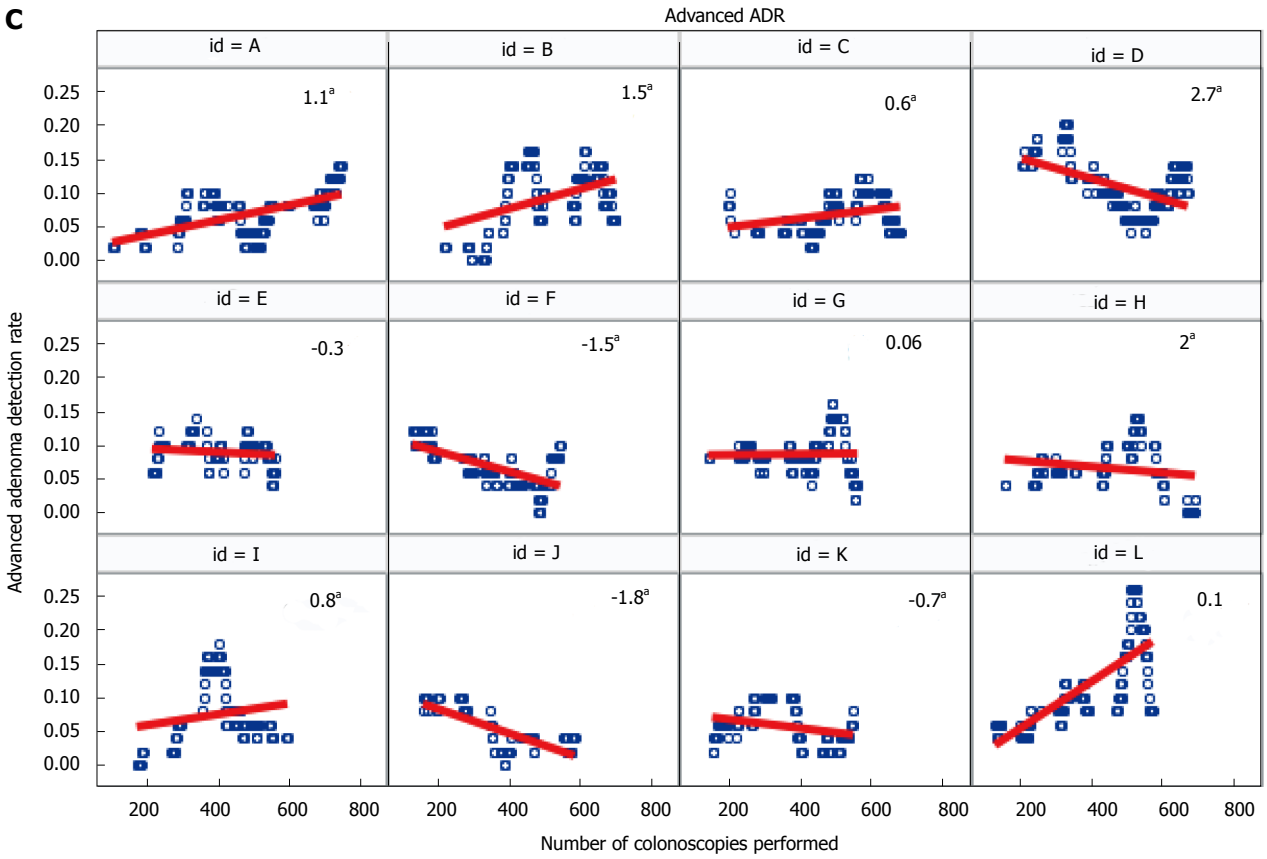

Figure 3 Individual change trajectories of the three main quality metrics for 12 fellows throughout their fellowship training. A: ADR; B: PDR; C: Advanced ADR. The numbers in the top right corner of each panel represent the slope (absolute percentage increase in outcome per 100 screening colonoscopies). The [a] represents statistically significant ($P < 0.05$) slopes. Models included the outcome and procedural volume (main exposure). ADR: Adenoma detection rate; PDR: Polyp detection rate.

procedures. This is highly plausible because polyp detection requires skill in colon distension, residual stool cleanup, and deliberate and systematic examination of each colon fold. The improvement in adenoma detection (as measured by the ADR and APC) was mainly observed in the right colon. The reason behind this finding is unclear. In our study, all patients received a single dose colon preparation the night prior to the colonoscopy. This may have led to the presence of residual stool preferentially in the right colon[20], which needs to be cleaned adequately to improve polyp detection. Previous studies found that cleaning the colon of residual stool by using air, water, and suction is an important motor skill in colonoscopy that improves with increasing procedural volume[13]. Therefore, it is possible that as this skill improved in our fellows, ADR and PDR increased in the right colon.

Traditional ways of assessing competence in colonoscopy have not included polyp detection, but rather focused on other metrics such as cecal intubation rate (> 90%), cecal intubation times, rate of ileocecal valve intubation, patient comfort level, and number of biopsy forceps passes for removal of small polyps. More recently, a dedicated colonoscopy skill assessment tool was developed [Assessment of Competency in Endoscopy (ACE) tool] that incorporates several motor and cognitive skills, in addition to polyp detection. In a multicenter prospective assessment of the ACE tool that included gastroenterology fellows at various stages of training over a one-year period, there was a gradual increase in the PDR from 24% early in training to 65% by the end of training[13]. The ACE tool does not include the ADR or other metrics (APC, PPC). In our study, we found a similar overall upward trend in the ADR and PDR throughout fellowship training. This suggests that measurement of the PDR for competency assessment, while not ideal, could be sufficient for assessing fellows' polyp detection skills. However, it is important to mention that the PDR is a "corruptible" measure of quality, with potential for the endoscopists (including fellows) to artificially inflate their PDR by removing insignificant diminutive polyps. The ADR remains the most objective and validated quality measure of colonoscopy.

The number of colonoscopies needed to achieve competence is a matter of continuous debate. It has been consistently found in retrospective and prospective studies that the previously recommended number of 140 colonoscopies is inadequate for achieving competence[10,11,13,17,21]. Furthermore, there is a general shift towards performance-based assessment of competency, and away from merely documenting the

number of procedures performed[21]. Nevertheless, our findings support the need for a higher number of colonoscopies. Using the ADR and APC of attendings as a reference standard, we found that it requires 265 and 400 procedures to achieve the reference ADR and APC, respectively. This is in accordance with the most recent literature and guidelines for privileging and credentialing, which recommend a minimum of 275 colonoscopies before assessment of competence and seeking of privileges[22]. It is noteworthy that we did not use the recommended minimal quality metrics (ADR of 25%) in calculating the number of required procedures because the average initial ADR for the fellows in the study was already 25.1% at the first measurement occasion.

Our study has several strengths. To our knowledge, we included the largest number of fellows to be followed longitudinally throughout their fellowship training. Our unique method of analysis allowed us to evaluate individual as well as combined trajectories of change in polyp detection. Previous studies used a linear regression analysis method to examine the change in the ADR with procedural volume[23]. This method of analysis is suboptimal because the observations are not independent, but are interrelated and performed by the same gastroenterology fellows over time. A longitudinal analysis method considers the individual and combined change trajectories, examines the change in outcome with time, and allows for estimation of outcome at different time points by using the initial ADR and other detection rates and their rates of change. Furthermore, this method allows comparison of different trends even if values are not available for all fellows at all time points. When calculating the ADR and other outcomes, we only included screening colonoscopies and excluded colonoscopies performed for polyp surveillance and for diagnostic indications; nevertheless, we included all colonoscopies in the calculation of procedural volume. We believe that this approach provides a valid estimation of the ADR and other outcomes, while still incorporating an accurate measure of procedural experience. Previous studies examined differences in polyp detection among fellows according to their year of training. However, using procedural volume is likely a better approach because fellows perform a variable number of procedures during their years of training. The ADR and other polyp detection outcomes were measured using a fixed number of colonoscopies at each time point (50 procedures) which eliminated the variability in these values that can occur if a different number of procedures is used at each time point. We also adjusted for important time-varying predictors of polyp detection in the combined model to account for the varying contribution of these factors on colonoscopy outcomes. Our study extends the traditional analysis of polyp detection beyond the ADR and PDR to include other outcomes such as the advanced ADR, APC, and PPC, and the right- *vs* left-side detection rates, thereby providing more insight into changes in these outcomes with increasing procedural volume and skill in colonoscopy.

The study also has several limitations. We did not evaluate the exact involvement of fellows in the procedure. Part of the withdrawal could have been performed by the attendings, especially for first year fellows. We did not evaluate other features of fellows' performance such as independent cecal intubation rates, insertion, and withdrawal times. This would have given more insight into the learning curves of the fellows in respect to motor skills in addition to polyp detection, and would have helped evaluate whether withdrawal times are linked to higher polyp detection by fellows. Our study was limited to one gastroenterology training program with a small number of supervising attendings, and our results may not be generalizable to other gastroenterology programs. This study focused on procedural volume as a determinant of improvement in polyp detection. However, the quality of the endoscopic and didactic training of fellows is also important when considering improvement in their polyp detection skills.

Measurement of the ADR is an essential component of continuous quality improvement in colonoscopy, and is an important metric for all practicing gastroenterologists. Yet there are no requirements for measuring the ADR or PDR during fellowship training, and there seems to be a gap in trainee knowledge when it comes to quality in colonoscopy. In a survey of gastroenterology trainees, less than 50% of respondents correctly identified the recommended national benchmarks for ADR[24]. The inclusion of the ADR (or the less preferred PDR) as a component of the colonoscopy assessment tool is a critical step towards a more objective measure of trainee performance, and provides the needed emphasis on quality of colonoscopy during training. It is likely that fellows achieve a 90% cecal intubation rate long before they acquire the necessary skills to improve their polyp detection skills. Therefore, we recommend establishing a separate category of "colonoscopy quality" for assessing colonoscopy skills. To do this, fellows can be evaluated using objective colonoscopy assessment tools (*e.g.*, the ACE tool) and periodically given an overall motor skill score, cognitive skill score, and quality score (ADR or PDR). Despite the overall increase in the ADR and PDR, we found that fellows vary substantially in their individual polyp detection rates (Table 1 and Figure 1). In addition, there are intra-individual variations and fluctuations in ADR, PDR and AADR throughout fellowship training (Figure 3), which are likely substantially related to variations in the characteristics of patients undergoing colonoscopy (*e.g.*, true numbers of polyps/adenomas, age, prep quality). Therefore, it is important to measure these metrics at multiple intervals throughout fellowship in order to evaluate trends rather than inappropriately weighing a single value. A few fellows had a relatively low ADR and PDR even in their later stages of training. Such trainees could benefit from targeted feedback and training to improve their polyp detection. Some

studies found that providing a quality report card to gastroenterologists results in an improved ADR[25,26]. It is unclear whether this would have a similar effect on trainees during fellowship. Nevertheless, continuous measurement of the ADR during fellowship could instill the habit of quality monitoring, provide opportunities for self-improvement, and prepare fellows for similar activities when they start practicing as independent gastroenterologists.

In summary, we found that the ADR, PDR, and other indicators of polyp detection increase with increasing colonoscopy volume during training, and that it requires between 265-400 colonoscopies for fellows to reach the adenoma detection level of attendings. We recommend increased focus on colonoscopy quality during fellowship training, with establishment of a separate colonoscopy quality score for each fellow to be incorporated in periodic trainee feedback and evaluations.

COMMENTS

Background

Adenoma and polyp detection rates (ADR and PDR) are important quality metrics for colonoscopy. Several studies found that participation of gastroenterology fellows in screening colonoscopies is associated with increased ADR and PDR. During gastroenterology training, competency in colonoscopy is measured by the ability of the trainee to achieve cecal intubation in a timely manner (< 15 min) and resect polyps independently.

Research frontiers

In addition to traditional milestones of competence in colonoscopy, it is important to examine the effect of procedural volume on the quality of colonoscopy performed by fellows under the supervision of attendings. The aim of this study was to investigate changes in polyp detection throughout fellowship training, and estimate the colonoscopy volume required to achieve the ADRs and PDRs of attending gastroenterologists.

Innovations and breakthroughs

The authors performed a retrospective cohort study of 12 fellows who completed three full years of training. The authors examined the change in ADR, PDR, and advanced ADR for each individual fellow and as a group using longitudinal modelling. The majority of fellows increased their ADR and PDR throughout their fellowship training as they performed more colonoscopies. The ADR increase was limited to the right side of the colon, while the PDR increased for both the right and left colon. The adenoma per colon and polyp per colon also increased throughout training, providing further evidence that polyp detection is a skill that continues to improve throughout fellowship. Fellows reached ADR and PDR levels similar to those of the attendings' average values after 265 and 292 colonoscopies, respectively.

Applications

This study provides important insight into the progression of polyp detection skills of trainees throughout fellowship. It also supports the recent recommendations of $\geqslant$ 275 colonoscopies for colonoscopy credentialing. Quality metrics during fellowship training could complement other evaluation tools for colonoscopy training. Fellows should monitor their own ADR throughout fellowship and strive for continued improvement.

Peer-review

The manuscript written by Qayed *et al* analyzed the relation between adenoma or polyp detection rates and colonoscopy volume. They found that ADR and PDR increase with increasing colonoscopy volume throughout fellowship. The data are well analyzed and important.

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META-ANALYSIS

Safety of gastrointestinal endoscopy with conscious sedation in obstructive sleep apnea

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Author contributions: Andrade CM and Patel B contributed to conception and design, acquisition of data; Andrade CM, Patel B and Vellanki M interpreted the data, drafted the article; Kumar A and Vidyarthi G analyzed and interpreted the data; Vidyarthi G revised the article; all authors approved the final version to be submitted.

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Abstract

AIM

To perform a systematic review and meta-analysis to assess the safety of conscious sedation in patients with obstructive sleep apnea (OSA).

METHODS

A comprehensive electronic search of MEDLINE and EMBASE was performed from inception until March 1, 2015. In an effort to include unpublished data, abstracts from prior gastroenterological society meetings as well as other reference sources were interrogated. After study selection, two authors utilizing a standardized data extraction form collected the data independently. Any disagreements between authors were resolved by consensus among four authors. The methodological quality was assessed using the Newcastle Ottawa tool for observational studies. The primary variables of interest included incidence of hypoxia, hypotension, tachycardia, and bradycardia. Continuous data were summarized as odds ratio (OR) and 95%CI and pooled using generic inverse variance under the random-effects model. Heterogeneity between pooled studies was assessed using the I^2 statistic.

RESULTS

Initial search of MEDLINE and EMBASE identified 357 citations. A search of meeting abstracts did not yield any relevant citations. After systematic review and exclusion consensus meetings, seven studies met the a priori determined inclusion criteria. The overall methodological

quality of included studies ranged from moderate to low. No significant differences between OSA patients and controls were identified among any of the study variables: Incidence of hypoxia (7 studies, 3005 patients; OR = 1.11; 95%CI: 0.73-1.11; P = 0.47; I^2 = 0%), incidence of hypotension (4 studies, 2125 patients; OR = 1.10; 95%CI: 0.75-1.60; P = 0.63; I^2 = 0%), incidence of tachycardia (3 studies, 2030 patients; OR = 0.94; 95%CI: 0.53-1.65; P = 0.28; I^2 = 21%), and incidence of bradycardia (3 studies, 2030 patients; OR = 0.88; 95%CI: 0.63-1.22; P = 0.59; I^2 = 0%).

CONCLUSION

OSA is not a significant risk factor for cardiopulmonary complications in patients undergoing endoscopic procedures with conscious sedation.

Key words: Conscious sedation; Obstructive sleep apnea; Endoscopy; Complications; Safety; Meta-analysis

Core tip: Patients with obstructive sleep apnea (OSA) often receive monitored anesthesia care in lieu of conscious sedation due to a perceived elevated risk of complications. However, prior studies have failed to note any clinically significant variations in cardiopulmonary parameters in OSA patients when compared to controls during endoscopy but studies have been underpowered due to small sample sizes. The objective was to perform a systematic review and meta-analysis to assess the safety of conscious sedation in patients with OSA. This meta-analysis showed OSA is not a significant risk factor for cardiopulmonary complications in patients undergoing endoscopic procedures with conscious sedation.

Andrade CM, Patel B, Vellanki M, Kumar A, Vidyarthi G. Safety of gastrointestinal endoscopy with conscious sedation in obstructive sleep apnea. *World J Gastrointest Endosc* 2017; 9(11): 552-557 Available from: URL: http://www.wjgnet.com/1948-5190/full/v9/i11/552.htm DOI: http://dx.doi.org/10.4253/wjge.v9.i11.552

INTRODUCTION

Obstructive sleep apnea (OSA) is an increasingly common disorder. Because of a presumed elevated risk, endoscopic evaluation in patients with OSA may be delayed, denied or achieved at a higher level of care resulting in substantial healthcare expenses. In the general population, adverse events during endoscopy are rare with an approximate adverse event rate of 0.1% and 0.2% for upper gastrointestinal and lower gastrointestinal procedures respectively[1-4]. Non-significant variations in cardiopulmonary parameters are usually noted during routine endoscopy and have been well studied[5-7]. Several published studies, including a recently reported prospective study evaluating the risk of cardiopulmonary complications in patients with OSA undergoing endoscopy with conscious sedation have not supported the need for extra precaution[8]. We recently published a prospective analysis in the veteran population undergoing upper and lower endoscopy which did not find any significant cardiopulmonary variation in control and OSA patients[8].

Despite their comparable findings, these conclusions are limited by small sample sizes in conjunction with low adverse event rates. No systematic reviews or meta-analyses have been performed on this topic to date. The present study aims to systematically review the literature and perform a meta-analysis of all selected published and unpublished data meeting search criteria on patients with OSA undergoing endoscopic procedures.

MATERIALS AND METHODS

Selection criteria

A comprehensive electronic search of MEDLINE and EMBASE was performed from inception until March 1, 2015. A total of 119 MEDLINE references were identified using the following search strategy: (apnea) OR "sleep apnea") OR sleep apnea) OR obstructive sleep apnea) OR "obstructive sleep apnea") OR sleep disordered breathing) OR "sleep disordered breathing") AND (sedation) OR conscious sedation) OR "conscious sedation") OR moderate sedation) OR "moderate sedation") AND endoscopy. A total of 238 EMBASE references were identified using the following strategy: Endoscopy AND (Apnea OR (sleep AND disordered AND breathing) OR "sleep disordered breathing" OR "obstructive sleep apnea" OR "sleep apnea" OR (sleep AND apnea) OR (obstructive AND sleep AND apnea) AND (Sedation OR "conscious sedation" OR (conscious AND sedation) OR "moderate sedation" OR (moderate AND sedation) AND human. Two authors evaluated the combined 357 candidate studies independently. Studies performed on patients with obstructive sleep apnea undergoing endoscopy with conscious sedation and at least one the following variables of interest were considered for inclusion: Incidence of hypoxia, hypotension, tachycardia, and bradycardia.

Data collection

Two authors extracted all data independently utilizing a standardized data extraction form. Once the data was entered into a dataset, a random data check was performed for accuracy. All disagreements between authors were resolved by consensus with a third author. Data were collected on study and patient characteristics, OSA groups, use of conscious sedation and the incidences of hypoxia, hypotension, tachycardia, and bradycardia when available. The methodological quality was assessed using the Newcastle Ottawa tool for observational studies[9]. The primary variables of interest included incidence of hypoxia, hypotension, tachycardia, and bradycardia. The systematic review was performed and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)

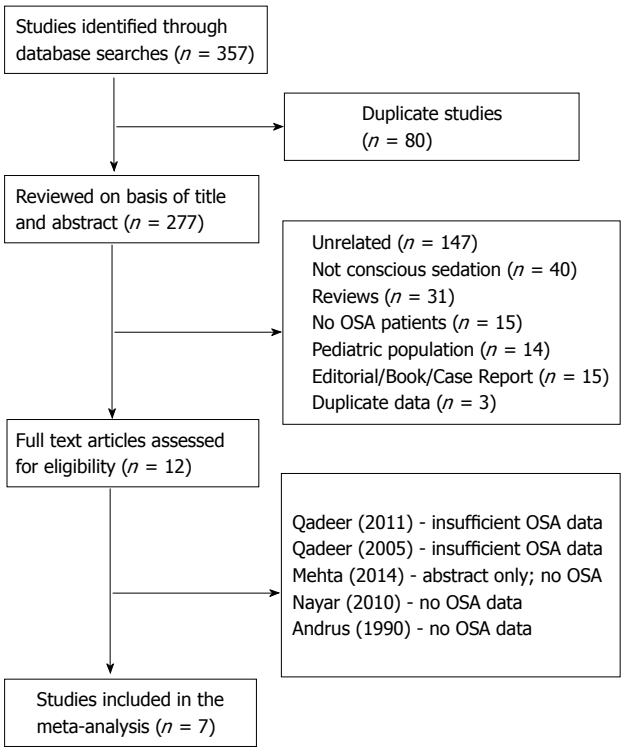

Figure 1 Flow diagram of study selection[22-25]. OSA: Obstructive sleep apnea.

guidelines[10].

Statistical analysis

Continuous data were summarized as odds ratio (OR) and 95%CI and pooled using generic inverse variance under the random-effects model. Heterogeneity between pooled studies was assessed using I^2 statistic and categorized as low (< 30%), moderate (30%-50%), or high (> 50%)[11]. All analyses were performed using Review Manager 5.1 software[12].

Biostatistics

The statistical methods of this study were performed and reviewed by a biomedical statistician, Ambuj Kumar, MD, MPH from Comparative Effectiveness Research, Morsani College of Medicine, University of South Florida, Tampa, FL, United States.

RESULTS

Study selection

A comprehensive search of MEDLINE and EMBASE identified 357 eligible citations. In an effort to capture unpublished data, conference abstracts from the last 3 meetings (2013-2015) of the American College of Gastroenterology and Digestive Disease Week were also reviewed. No studies were identified to meet inclusion criteria. The following sites were also interrogated for possible study inclusion: ClinicalTrials.gov, Roche clinical trial protocol registry (www.roche-trials.com), Novartis clinical trials database (www.novctrd.com), Australian New Zealand Clinical Trials Registry (ANZCTR), and the metaRegister of Controlled Trials. No additional studies were identified for inclusion.

After systematic review and exclusion consensus meetings, seven studies met the a priori determined inclusion criteria (Figure 1). None of the references from the included studies yielded additional studies eligible for inclusion. The overall methodological quality of the included studies ranged from moderate to low as assessed by the Newcastle Ottawa tool for observational studies[9].

Hypoxia

Seven studies identified for inclusion contained data on the incidence of hypoxia. A total of 3005 patients were included for analysis. No significant differences between OSA patients and controls were identified with regards to the incidence of hypoxia (OR = 1.11; 95%CI: 0.73-1.11; P = 0.47, Figure 2). The heterogeneity among the studies was low (I^2 = 0%).

Hypotension

Four studies identified for inclusion contained data on the incidence of hypotension. A total of 2125 patients were included for analysis. No significant differences between OSA patients and controls were identified with regards to the incidence of hypotension (OR = 1.10; 95%CI: 0.75-1.60; P = 0.63, Figure 3). The heterogeneity among the studies was low (I^2 = 0%).

Tachycardia

Three studies identified for inclusion contained data on the incidence of tachycardia. A total of 2030 patients were included for analysis. No significant differences between OSA patients and controls were identified with regards to the incidence of tachycardia (OR = 0.94; 95%CI: 0.53-1.65; P = 0.28, Figure 4). The heterogeneity among the studies was low (I^2 = 21%).

Bradycardia

Three studies identified for inclusion contained data on the incidence of bradycardia. A total of 2030 patients were included for analysis. No significant differences between OSA patients and controls were identified with regards to the incidence of bradycardia (OR = 0.88; 95%CI: 0.63-1.22; P = 0.59, Figure 5). The heterogeneity among the studies was low (I^2 = 0%).

DISCUSSION

OSA is a growing problem in the United States especially among the veteran population. Moderate to severe OSA is estimated to affect approximately 13% of men and 6% women between the ages of 30-70[13]. Per the ASGE sedation guidelines, patient with OSA are considered to be at a higher risk regarding sedation-related cardiopulmonary complications in relation to upper and lower endoscopy[14]. These patients are routinely recommended MAC anesthesia for endoscopic

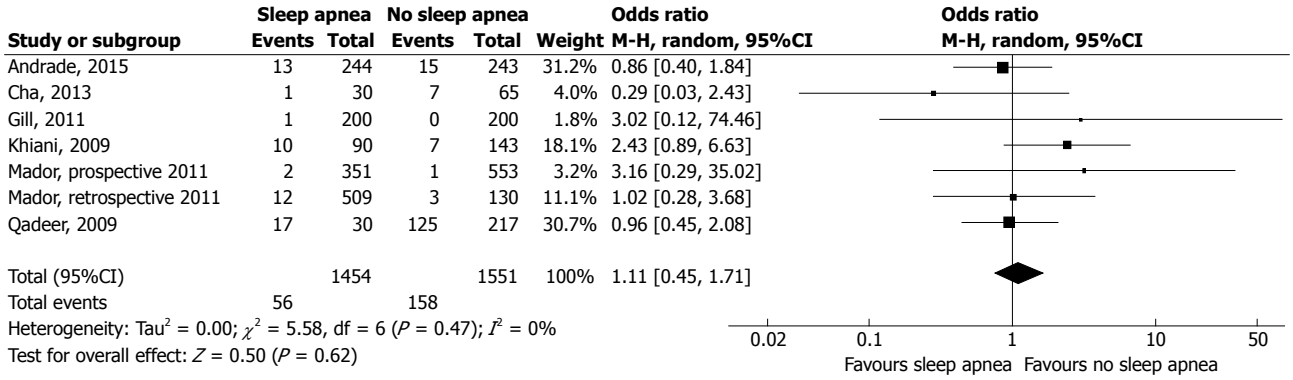

Figure 2 Incidence of hypoxia[8,17-21].

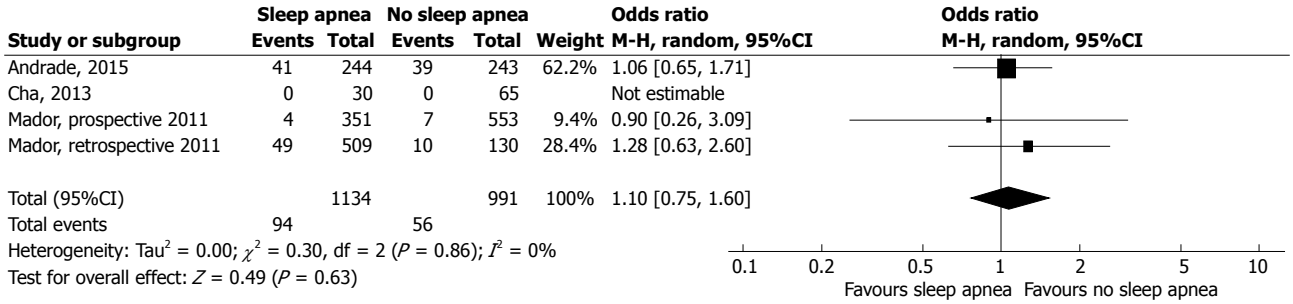

Figure 3 Incidence of hypotension[8,17,20,21].

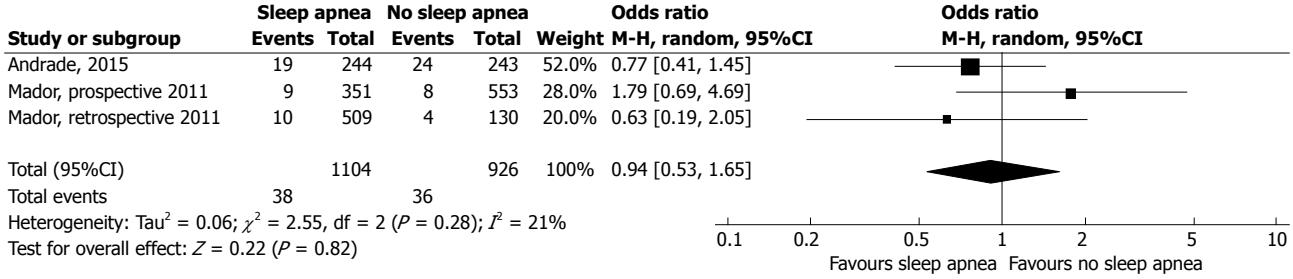

Figure 4 Incidence of tachycardia[8,20,21].

evaluation. Cardiopulmonary complications are the most feared unfavorable events among patients with OSA including episodes of tachycardia, bradycardia, hypotension, and hypoxia[5-7]. It is believed that OSA patients especially tend to have poor respiratory drive and effort which can be exacerbated by sedation[15,16]. Contrary to that belief, our meta-analysis and review does not show any significant difference in regards to hypoxia in OSA patients. It is also well studied that sedation tend to lower overall mean blood pressure. When looking at cardio-circulatory parameters including bradycardia, tachycardia and hypotension, our review failed to show any significant difference in regards to those parameters. Therefore, in patients undergoing endoscopy with conscious sedation, OSA does not seem to be a clinically important risk factor for unfavorable outcomes. In short, significant differences between OSA patients and controls were not identified among any of the study variables: Incidence of hypoxia, hypotension, tachycardia or bradycardia. This is in correlation with regards to the recent publication from our institution highlighting the cardiopulmonary parameters in the OSA and non-OSA patients[8]. OSA patients are perceived as high risk for endoscopy and are offered monitored anesthesia care routinely although this meta-analysis suggests otherwise. Moving forward, endoscopists should be cognizant that OSA does not predispose patients to higher risk compared to non OSA patients. In addition, using conscious sedation for OSA patients may reduce overall healthcare burden with cost saving measures as MAC anesthesia care has not necessarily shown any overall reduction in adverse events. A major limitation of the study includes the overall methodological quality of the included studies ranged from moderate to low. Further, for patients undergoing endoscopic procedures with conscious sedation, OSA does not appear to be a

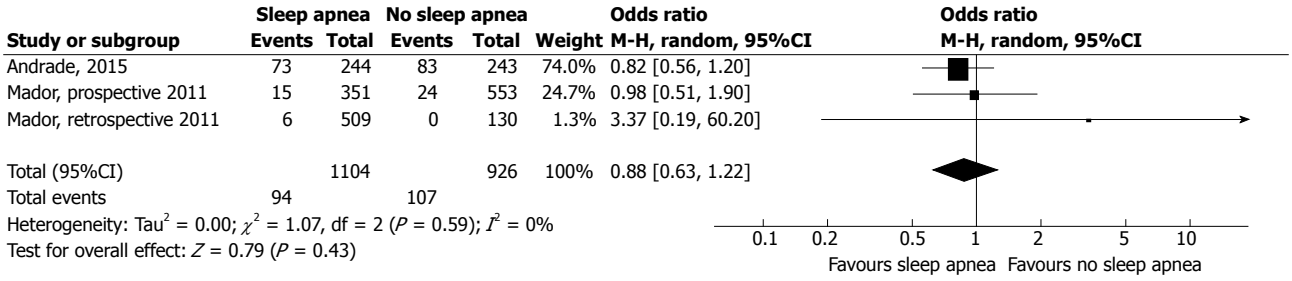

Figure 5 Incidence of bradycardia[8,20,21].

significant risk factor for cardiopulmonary complications. Future prospective studies must be conducted to evaluate the cost effectiveness and safety of endoscopy with MAC in the OSA population.

COMMENTS

Background

Patients with obstructive sleep apnea (OSA) often receive monitored anesthesia care in lieu of conscious sedation due to a perceived elevated risk of complications. However, prior studies have failed to note any clinically significant variations in cardiopulmonary parameters in OSA patients when compared to controls during endoscopy but studies have been underpowered due to small sample sizes. The authors aim was to perform a systematic review and meta-analysis to assess the safety of conscious sedation in patients with obstructive sleep apnea (OSA).

Research frontiers

This meta-analysis has demonstrated that OSA does not appear to be a significant risk factor for cardiopulmonary complications in patients undergoing endoscopy. Future prospective studies are needed to look at both the safety and cost-effectiveness of endoscopy with MAC in the OSA population.

Innovations and breakthroughs

This meta-analysis showed OSA is not a significant risk factor for cardiopulmonary complications in patients undergoing endoscopic procedures with conscious sedation, which has typically been the standard of care. These results further open the consideration of endoscopy without MAC in patients with OSA but future prospective studies are needed to look at both the safety and cost-effectiveness of endoscopy with MAC in the OSA population.

Applications

These findings can be considered by endoscopists when performing endoscopy with MAC in the OSA population in assessing their risk for procedural cardiopulmonary complications.

Terminology

Conscious sedation - The use of a sedative during a medical procedure that allows for a quick recovery; OSA - A sleep disorder that causes breathing to start and stop during sleep due to airway obstruction during sleep; Endoscopy - A procedure which uses an endoscope, or a long flexible tube with a camera to examine the upper GI tract.

Peer-review

The author gave a systematic review and meta-analysis about the safety of gastrointestinal endoscopy with conscious sedation in patients with OSA. The manuscript was concise and helpful for us to be cognizant that OSA does not appear to be a clinically significant risk factor for adverse outcomes in patients undergoing endoscopy with conscious sedation.

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LETTERS TO THE EDITOR

Efficacy of Prucalopride in bowel cleansing before colonoscopy: Results of a pilot study

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Lucia D'Alba, Gastroenterology and Digestive Endoscopy, San Giovanni-Addolorata Hospital, 00184 Rome, Italy

Author contributions: Corleto VD, D'Alba L and di Giulio E planned the study, performed all the colonoscopies and revised the final version of the paper; Antonelli G and Coluccio C enrolled patients, obtained informed consent, interpreted the data, wrote and revised the paper; all authors approved the final version.

Conflict-of-interest statement: All authors decline any conflict of interest regarding this paper.

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Abstract

Colonoscopy is a crucial diagnostic instrument for colorectal cancer screening and an adequate bowel preparation is definitely decisive for the success of the procedure. Especially in elderly patients, bowel cleansing is considered a big issue, because it is often poorly tolerated for many reasons (like inability to swallow large volume of liquids or unlikable taste); this can cause a suboptimal preparation that may lead to miss a neoplastic lesion. There is relatively little data about how to improve preparation tolerability. The purpose of our pilot study was to analyze the effect of prucalopride (Resolor®), a highly selective serotonin 5HT4 receptor agonist used for chronic constipation for its ability to stimulate gastrointestinal peristalsis, undertaken the day before colonoscopy, followed by half volume of polyethylene glycol solution. We found that this can be a good and safe method to achieve an adequate and better-tolerated colon cleansing.

Key words: Bowel cleansing; Colonoscopy; Prucalopride; Screening; Colorectal cancer

Core tip: Efficacy of bowel cleansing is of crucial importance in screening colonoscopies for the prevention and early detection of colorectal cancer. Many categories of patients however cannot tolerate the large volume of liquids that make up standard bowel cleansing regimens. Aim of our pilot study was to test the efficacy of prucalopride, a highly selective 5HT4 receptor agonist that increases bowel movements, in improving bowel cleansing and reducing the necessary volume of liquids.

Corleto VD, Antonelli G, Coluccio C, D'Alba L, di Giulio E. Efficacy of Prucalopride in bowel cleansing before colonoscopy: Results of a pilot study. *World J Gastrointest Endosc* 2017; 9(11): 558-560 Available from: URL: http://www.wjgnet.com/1948-5190/full/v9/i11/558.htm DOI: http://dx.doi.org/10.4253/wjge.v9.i11.558

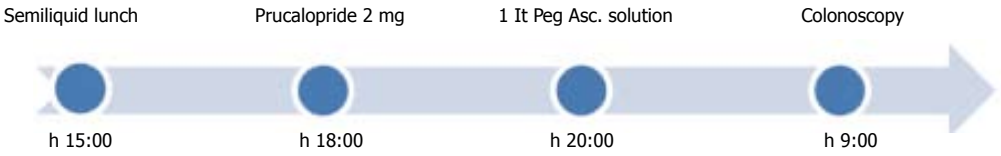

Figure 1 Time scale of Prucalopride preparation scheme.

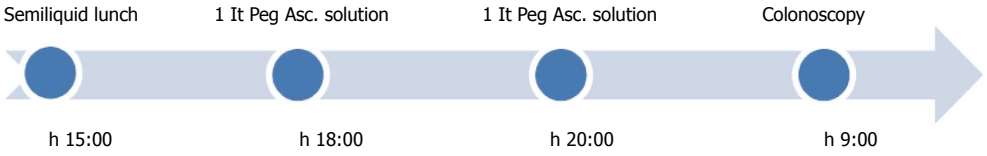

Figure 2 Time scale of standard preparation scheme.

Table 1 Demographic and anthropometric characteristics *n* (%)

	Standard preparation (2 L PEG-ASC) (*n* = 30)	Prucalopride + 1 L PEG-ASC (*n* = 30)
Age median (range)	53 (46-67)	55 (48-64)
Sex	14 (47)	14 (47)
BMI median (range)	26.7 (18.4-32.8)	25.4 (17.3-31)
Boston scale ⩾ 7	26 (87)	25 (83)
Boston scale ⩽ 6	4 (13)	5 (17)
Exam indication		
Screening	18 (60)	16 (53)
Follow up	12 (40)	14 (47)
Adenoma detection rate (%)	32	29
Time to preparation (h) median (range)	11.30 (10.45-12.30)	11.45 (10.30-12.45)
Colonoscopy insertion time (min), median (range)	8.2 (3.3-36)	7.6 (3.1-47)

PEG: Polyethylene glycol; BMI: Body mass index.

TO THE EDITOR

Adequacy of preparation is one of the most important factors[1] in screening and early detection of colorectal cancer (CRC), which still has a high incidence and mortality. Poor colon cleansing however still affects as many as 20% of colonoscopies, increasing burden for patients and total costs of colon cancer screening programs[1,2]. Patient tolerability is strongly affected by the chosen preparation and manner in which it is administered. Many factors have been identified to influence bowel preparation such as unappealing taste of the solution or inability to swallow large volumes of liquids. There have been many efforts to improve bowel cleansing like smaller volume solutions, tablets consumed with water and split-dose regimens[3,4].

Prucalopride, a highly selective serotonin 5HT4 receptor agonist used for treatment of chronic constipation, stimulates gastrointestinal peristalsis and colon movements[5,6]. It is a generally well tolerated drug, contraindicated only in patients on dialysis or with bowel perforation or obstruction. The most common side effects are fatigue, appetite loss, diarrhea and headache at first dose administration[5,6]. In the present pilot study we tested the hypothesis that a previous dose of Prucalopride followed by a low volume of polyethylene glycol (PEG) solution, might achieve a satisfactory colon cleansing.

A total of 30 consecutive patients, 16F, 14M, mean age 55 years (48-62) (complete characteristics available in Table 1), all with regular bowel movements, after written informed consent, agreed to use the following preparation schedule: on the day before the examination, 3 h after a semi-liquid midday meal, 2 mg of Prucalopride, and later in the evening, 1 L of PEG-Asc. solution followed by the assumption of water or other clear liquids (> 1 L) (Figure 1). A control group of 30 patients with comparable characteristics followed the standard 2 L PEG-ASC. Preparation schedule (Figure 2). All patients underwent colonoscopy either for CRC screening or for periodical survey. All had four days of low fiber diet and all examinations were performed the following morning. The colonoscopies were performed by senior endoscopists who were unaware of the preparation schedule at the time of the examination. Twelve out of 14 patients of the Prucalopride group, who were undergoing colonoscopy for follow up of previous examinations, declared that the new preparation schedule was more acceptable compared to the standard one. Specifically, none of them reported nausea and/or retching during assumption of the PEG-ASC.

Colonoscopy was completed (caecal intubation) in all patients studied. Insertion time is reported in Table 1. The colon cleansing was rated good/optimal (Boston scale 7-9) in 26/30 (87%) and in 25/30 (83%) in study and controls group respectively. The adenoma detection rate (ADR) among the two groups was comparable (Table 1). Among patients receiving Prucalopride, two patients had mild headache in the following three hours after its administration. Among patients receiving standard dose, two patients reported nausea and one patient reported mild abdominal pain during assumption.

Our pilot study shows that previous Prucalopride administration followed by half dose PEG solution produced comparable colon cleansing quality than regular

standard dose. Faster intestinal transit with intestinal residuals removal stimulated by previous Prucalopride administration might explain why a reduced volume of preparation solution could achieve a satisfactory bowel cleansing. These results must be further investigated by a wider, prospective, randomized control trial that can confirm these preliminary findings and facilitate colon cleansing for those patients that are unable to drink large volumes of liquid.

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