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ABOUT COVER

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Retrospective Cohort Study

Preoperative bowel preparation does not favor the management of colorectal anastomotic leak

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statement: The NSQIP data base is a de-identified patient database and consequently our study was

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Abstract

BACKGROUND

Controversy exists regarding the impact of preoperative bowel preparation on patients undergoing colorectal surgery. This is due to previous research studies, which fail to demonstrate protective effects of mechanical bowel preparation against postoperative complications. However, in recent studies, combination therapy with oral antibiotics (OAB) and mechanical bowel preparation seems to be beneficial for patients undergoing an elective colorectal operation.

AIM

To determine the association between preoperative bowel preparation and postoperative anastomotic leak management (surgical *vs* non-surgical).

METHODS

Patients with anastomotic leak after colorectal surgery were identified from the 2013 and 2014 Colectomy Targeted American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database and were employed for analysis. Every patient was assigned to one of three following groups based on the type of preoperative bowel preparation: first group-mechanical bowel preparation in combination with OAB, second group-mechanical bowel preparation alone, and third group-no preparation.

RESULTS

A total of 652 patients had anastomotic leak after a colectomy from January 1, 2013 through December 31, 2014. Baseline characteristics were assessed and

exempt from institutional review board (IRB) approval.

Conflict-of-interest statement: We have no conflict of interest to declare.

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found that there were no statistically significant differences between the three groups in terms of age, gender, American Society of Anesthesiologists score, and other preoperative characteristics. A χ^2 test of homogeneity was conducted and there was no statistically/clinically significant difference between the three categories of bowel preparation in terms of reoperation.

CONCLUSION

The implementation of mechanical bowel preparation and antibiotic use in patients who are going to undergo a colon resection does not influence the treatment of any possible anastomotic leakage.

Key words: Preoperative bowel preparation; Preoperative mechanical bowel preparation; Preoperative oral antibiotics; Colorectal anastomotic leak; Anastomotic leak; Bowel preparation; Colorectal surgery; National Surgical Quality Improvement Program

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Core tip: Anastomotic leak after colon resection contributes significantly to postoperative morbidity and mortality. Surgeons are constantly seeking ways to decrease the rate of the anastomotic leak by optimizing the patient before the operation. Currently the preoperative bowel preparation constitutes a significant field of debate. We aimed to determine the association between preoperative bowel preparation and postoperative anastomotic leak management, surgical versus non-surgical. We found that the implementation of mechanical bowel preparation and antibiotic use in patients who are going to undergo a colon resection does not influence the treatment of any possible anastomotic leakage.

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INTRODUCTION

Anastomotic leak after colon resection is one of the feared complications in general surgery, with a reported incidence in the literature varying as broadly as 3.4% to 40%^[1]. An acceptable overall leak rate among experienced colorectal surgeons is between 3% and 6%^[2]. Anastomotic leak contributes significantly to postoperative morbidity and mortality, and it also increases the risk of local recurrence for cancer patients^[1,3,4]. Several risk factors have been linked to anastomotic leakage, both preoperative and intraoperative. Examples include emergent operation, a high American Society of Anesthesiologists (ASA) score, age greater than 70 years, low serum albumin, prolonged operative time, body mass index (BMI), and several others^[2,5-7]. For these reasons, surgeons are constantly seeking ways to decrease the rate of the anastomotic leak, as well as its consequences, by optimizing the patient before the operation.

The idea of preoperative bowel preparation with oral antibiotics (OAB) before an elective colon resection was first proposed by Poth *et al*^[8] in 1942. Later in 1971, Nichols *et al*^[9] introduced the combination of mechanical bowel preparation with OAB prior to elective colon surgery with the intent of reducing intraluminal fecal bulk and increasing delivery of antibiotics to colonic mucosa. Since then this combination has been regarded as an effective strategy for preventing anastomotic leak^[9]. The benefit of this combination with the more widespread adoption of intravenous perioperative antibiotics, however, has been contested, as numerous studies have failed to demonstrate a protective effect against postoperative complications. Currently the optimal preoperative bowel preparation constitutes a significant field of debate^[10]. More recent observational studies indicate that administration of combined preoperative mechanical bowel preparation (MBP) and OAB offers a protective effect by significantly reducing the incidence of anastomotic leaks, surgical site infection, and mortality^[3,11].

There is a variable clinical presentation of anastomotic leakage. Ranging from full luminal dehiscence with peritonitis, localized abscess, or subclinical leak with omental or serosal seal, often associated with ileus or systemic inflammatory response. We hypothesized that administration of MBP + OAB, by reducing and altering luminal bacterial content may diminish the clinical severity of anastomotic leak. There is evolving evidence that the amount and species of intestinal bacteria play an important role in anastomotic healing^[4]. We aimed to determine the association between preoperative bowel preparation and postoperative anastomotic leak management. Building upon the protective role of MBP and OAB in the incidence of leakage, we hypothesized that patients experiencing anastomotic leaks following preoperative bowel preparation would be less likely to require reoperation for leak management.

MATERIALS AND METHODS

The 2013 and 2014 Colectomy Targeted American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) databases were merged with the 2013 and 2014 ACS-NSQIP Participant User File (PUF) databases, and both were used to carry out this study. NSQIP collects information in a retrospective manner on more than 150 variables, including preoperative, intraoperative, and postoperative variables for patients undergoing major surgical procedures in both the inpatient and outpatient settings. NSQIP database benefits from several unique features of data collection, *i.e.*, the trained/certified collectors, the standardized variable definitions, and the diversity of participating hospitals in the program (more than 400). Complete details of NSQIP database have been published by Khuri *et al*^[12] in 1998. Patients were included in this study if they underwent a colorectal resection with anastomosis creation [current procedural codes (CPT) were 44140: Colectomy, partial; with anastomosis; 44145: Colectomy, partial, with coloproctostomy (low pelvic anastomosis); 44160 Colectomy, partial, with removal of terminal ileum with ileocolostomy; 44204 Laparoscopy, surgical colectomy, partial, with anastomosis; 44205 Laparoscopy, surgical colectomy, partial, with removal of terminal ileum with ileocolostomy; 44207 Laparoscopy, surgical colectomy, partial, with anastomosis, with coloproctostomy, low pelvic anastomosis] and subsequently had a postoperative anastomotic leak. As anastomotic leak was defined as leak of enteric content through an anastomosis and it was determined by the colectomy targeted database. Detailed information for the preoperative bowel preparation and the treatment mode of the leak complication were extracted from the Colectomy Targeted ACS-NSQIP databases, while information regarding the patients' baseline characteristics was obtained from the ACS-NSQIP PUF database. Patients without anastomosis or postoperative leak were excluded from our analysis. Patients were also excluded if they had undergone a non-elective operation, had any kind of ileostomy or colostomy, or had missing information regarding the bowel preparation or the leak treatment mode. Patients who received only antibiotics as preoperative bowel preparation were also excluded because it is not a common practice and the number of such patients was relatively small. These resulted in a final population of 652 patients for our study. The flowchart of the patient selection is depicted in [Figure 1](#). The NSQIP data base is a de-identified patient database and consequently our study was exempt from institutional review board (IRB) approval.

The primary outcome, a dichotomous categorical variable, was the clinical treatment modality (surgical *vs* non-surgical) of a patient with a postoperative anastomotic leak. As the primary predictor variable, we considered the preoperative bowel preparation, which was defined as a discrete variable with three categories: (1) MBP + OAB; (2) MBP alone; and (3) no preparation. Secondary predictor variables included patient's age, gender, BMI, race (which had the following three groups: (1) Caucasian; (2) African American; and (3) Other: (Asian, American Indian or Alaska Native, Native Hawaiian or Pacific Islander and Unknown), ASA score, diabetes mellitus status, preoperative steroid use, current smoking status, preoperative history of hypertension requiring treatment, preoperative weight loss > 10% in the last six months, preoperative history of bleeding disorder, type of operation based on the CPT code, preoperative chemotherapy, primary indication for surgery, preoperative anemia of patient by using the patient hematocrit, preoperative inflammation status of patient by using the preoperative white blood cells count, preoperative hemostasis status by using the patient's platelets count, the preoperative nutritional status by using the serum albumin level, and patient's renal function by using the serum blood urea nitrogen (BUN).

Statistical analysis

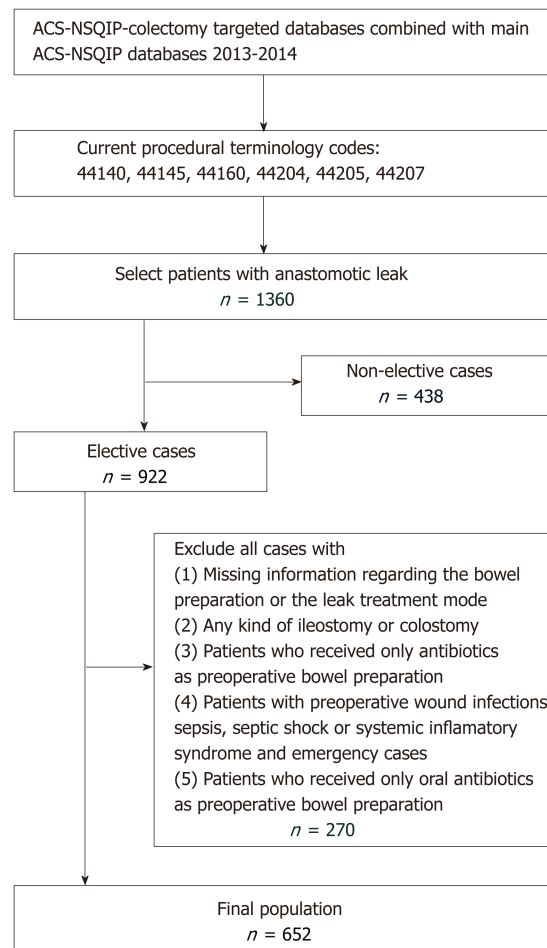


Figure 1 Flow chart of study cohort. ACS-NSQIP: American College of Surgeons National Surgical Quality Improvement Program.

Baseline characteristics of all patients in the three preoperative bowel preparation groups were assessed and compared, with the intention to detect any significant differences among the three groups that could potentially confound or modify the effect of preoperative bowel preparation on the primary outcome. Data on categorical variables were expressed as frequencies and proportions (%) and were compared between groups using the χ^2 or Fisher's exact test. Data on continuous variables are summarized with the usual descriptive statistics such as mean \pm SD, medians (ranges), and interquartile ranges; and group comparisons of these variables were performed using the Wilcoxon Test (for two groups) or Kruskal-Wallis (for three or more groups) test due to the fact that data contained outliers and were unlikely to follow a normal distribution. Univariable logistic regression models were used to examine the associations of individual predictor variables with the primary outcome one at a time. Finally, multivariable logistic regression was performed to ascertain the effects of all potential predictor variables on the likelihood of patients being treated with reoperation for the leak. Unadjusted raw or adjusted odds ratios and their 95% confidence intervals (CIs) were reported as appropriate. Two-tailed *P*-values of less than 0.05 were considered statistically significant. SPSS version 24 and SAS version 9.3 were used for all the data analyses.

RESULTS

Among 652 patients undergoing elective colon resection, with anastomotic leak, between January 2013 and December 2014, 163 (25%) received mechanical bowel preparation combined with OAB before the operation, 260 (39.9%) received only mechanical bowel preparation, and 229 (35.1%) received no preoperative bowel preparation. The baseline characteristics of the final study population are described in **Table 1**: Mean (SD) population age was 59.5 (14.7) years, the average (SD) BMI of the

population was 28.7 (7.0), 58.3% of the patients were males, 483 (74.1%) patients were of White race, 97 (14.9%) patients had diabetes mellitus preoperatively, and 66 (10.1%) patients were taking steroids preoperatively. There were no statistically significant differences between the three bowel preparation groups concerning age, gender, BMI, ASA score, diabetes mellitus, steroid use, smoking status, hypertension, bleeding disorder, preoperative chemotherapy, and indication for surgery (Table 1). However, a statistically significant racial difference among those three groups existed, that is, the lowest percentage of White patients in the no preparation group 65.1% (No Prep) compared with the other two groups: 73.6% in MBP + OAB and 82.3% in MBP (Table 1). A significant difference was found also in the distribution of CPT codes among the three groups (Table 1). Furthermore, all three groups were similar from the standpoint of preoperative inflammatory status (White blood cell counts), preoperative patient's hematocrit, preoperative coagulant status (patient's platelets), preoperative nutritional status (serum albumin), and preoperative renal function (BUN) (Table 1).

The overall rate of reoperation for leak treatment among the three groups of preoperative bowel preparation was quite impressive: 54%. A similar rate was found in the initial NSQIP database before applying our exclusive criteria. This was entirely opposite to what we had expected, bearing in mind the theoretical protective effect of the bowel preparation on the anastomotic leak. The rate of reoperation was higher in both groups of bowel preparation (MBP + OAB: 58.3% and MBP: 55%) compared with that in the no preparation group (49.8%) (Figure 2). However, these differences among the three bowel preparation groups did not reach the level of the conventional statistical significance ($P = 0.23$), and we cannot reject the null hypothesis of having the same reoperation rate in the three bowel preparation groups. Furthermore, 95 (58.3%) patients in the group of MBP + OAB, 143 (55%) patients in the group of MBP, and 114 (49.8%) patients in the group of no preparation underwent a second operation as the treatment of anastomosis leak. A univariable logistic regression using the three groups was performed and revealed a slightly lower, albeit not statistically significantly different, odds ratio of reoperation in those patients who received no preparation compared with those who received either MBP alone or MBP + OAB as well as a slightly lower, but not statistically significantly different, odds ratio in those patients who received MPB compared with those who received MBP + OAB (Table 2).

Other variables were also examined using univariable logistic regression for their potential associations with reoperation, but the only statistically significant predictor was BMI: a 44% increased odds of reoperation in patients with BMI ≥ 30 compared with those with BMI < 30 [OR (95%CI): 1.44 (1.03, 2.00); $P = 0.03$; Table 2]. Multiple logistic regression, however, did not produce further insights in predicting the odds of reoperation as a clinical management of anastomotic leak beyond that of the association of BMI and reoperation in our study population. On the other hand, between the two groups of leak treatment (Non-Surgical *vs* Reoperation), there were only two statistically significant differences: about 10 pounds of higher weight but only a slightly, non-significant higher BMI in the group of reoperations when compared to the non-surgical group and a statistically significant higher rate of preoperative blood transfusion in the group of reoperation (Table 3). The Non-Surgical and Reoperation groups were not statistically different regarding age, height, BMI, gender, race, diabetes mellitus, preoperative steroid use, ASA classification, and weight loss $>10\%$ in the last six months (Table 3). The difference in gender between non-surgical and reoperation groups was borderline significant (female: 45.7% *vs* 38.4% for non-surgical *vs* reoperation groups; $P = 0.06$).

DISCUSSION

In our study, we assessed the impact of preoperative bowel preparation on the management of postoperative anastomotic leak using the NSQIP database. We hypothesized that MBP + OAB bowel preparation may alter the microbiome and confer a protective clinical effect in the case of an anastomotic leak. However, we found that patients with postoperative anastomotic leakage are not affected favorably with preoperative bowel preparation. Conversely, we found that patients with anastomotic leak who took any form of bowel preparation exhibit a slightly higher rate of reoperation compared to patients who did not undergo any preparation. However, this difference did not reach the statistical significance.

For over a century, bowel preparation has been the standard of care in elective colorectal surgery^[10]. However, several studies demonstrated that, as an independent variable, MBP is not only an ineffective protective measure, but also may have deleterious effects on patient's health and healing. Contant *et al*^[5] published a

Table 1 Baseline demographic and laboratory characteristics of patients undergoing elective colorectal resection overall and by bowel preparation method

	MBP + OAB	MBP	No Prep	Overall	P value
Overall N (missing data)	n = 163 (25%)	n = 260 (39.9%)	n = 229 (35.1%)	n = 652 (100%)	
Age (missing: 3/0.5%)					
mean (SD)	57.69 (14.69)	60.61 (13.7)	59.48 (15.64)	59.48 (14.67)	
Median	60	61	60	61	0.26
Q1/Q3	47/69	52/71	49.25/72	50/71	
Age grouped n (%)					
≥ 65 yr	60 (37)	104 (40.2)	98 (43)	262 (40.4)	0.50
Gender (missing: 0%)					
Female	60 (36.8)	110 (42.3)	102 (44.5)	272 (41.7)	0.30
Male	103 (63.2)	150 (57.7)	127 (55.5)	380 (58.3)	
BMI (missing: 2/0.3%)					
Mean (SD)	28.65 (6.81)	28.94 (7.43)	28.52 (6.74)	28.72 (7.04)	
Median	27.05	27.60	27.89	27.75	0.96
Q1/Q3	24.23/32.03	24.06/32.35	23.4/32.28	23.9/32.15	
Race (missing: 0%)					
White	120 (73.6)	214 (82.3)	149 (65.1)	483 (74.1)	< 0.001
AA	21 (12.9)	11 (4.2)	18 (7.9)	50 (7.7)	
Other or unknown	22 (13.5)	35 (13.5)	62 (27.1)	119 (18.3)	
ASA score (missing: 0%)					
1-no disturb	3 (1.8)	3 (1.2)	9 (3.9)	15 (2.3)	0.34
2-mild disturb	68 (41.7)	110 (42.3)	91 (39.7)	269 (41.3)	
3-severe disturb	86 (52.8)	139 (53.5)	116 (50.7)	341 (52.3)	
≥ 4-life threat	6 (3.7)	8 (3.1)	13 (5.7)	27 (4.1)	
Diabetes mellitus (missing: 0%)	30 (18.4)	30 (11.5)	37 (16.2)	97 (14.9)	0.12
Preoperative steroid use (missing: 0%)	23 (14.1)	18 (6.9)	25 (10.9)	66 (10.1)	0.05
Current smoking status (missing: 0%)	33 (20.2)	60 (23.1)	40 (17.5)	133 (20.4)	0.31
Hypertension requiring treatment (missing: 0%)	83 (50.9)	125 (48.1)	110 (48)	318 (48.8)	0.82
Preoperative weight loss > 10% in last six months (missing: 0%)	15 (9.2)	11 (4.2)	9 (3.9)	35 (5.4)	0.04
Preoperative bleeding disorder (missing: 0%)	5 (3.1)	7 (2.7)	5 (2.2)	17 (2.6)	0.86
Current procedural code					
44140	23 (14.1)	56 (21.5)	46 (20.1)	125 (19.2)	0.007
44145	25 (15.3)	39 (15)	33 (14.4)	97 (14.9)	
44160	15 (9.2)	17 (6.5)	34 (14.8)	66 (10.1)	
44204	47 (28.8)	53 (20.4)	46 (20.1)	146 (22.4)	
44205	20 (12.3)	21 (8.1)	28 (12.2)	69 (10.6)	
44207	33 (20.2)	74 (28.5)	42 (18.3)	149 (22.9)	
Preoperative chemotherapy (missing: 2/0.3%)	19 (11.8)	20 (7.7)	23 (10.0)	62 (9.5)	0.36
Continue in next page					
Primary indication for surgery (missing: 0%)					
Colon cancer	68 (41.7)	127 (48.8)	112 (48.9)	307 (47.1)	0.06
Non-malignant polyp	16 (9.8)	32 (12.3)	23 (10)	71 (10.9)	
Inflammatory bowel disease	13 (8)	9 (3.5)	22 (9.6)	44 (6.7)	
Acute diverticulitis	10 (6.1)	14 (5.4)	10 (4.4)	34 (5.2)	
Chronic diverticular disease	37 (22.7)	41 (15.8)	27 (11.8)	105 (16.1)	
Other	19 (11.7)	37 (14.2)	35 (15.3)	91 (14)	
Preoperative hematocrit (%) (missing: 30/4.6%)					
n	153 (93.9)	247 (95)	222 (96.9)	622 (95.4)	
mean (SD)	38.95 (5.55)	39.14 (5.48)	38.36 (5.64)	38.82 (5.56)	
Median	39	39.5	39	39.2	0.38
Q1/Q3	35.6/42.9	35.8/43	34.1/42	35.4/42.7	
Preoperative white blood cells (K/cumm) (missing: 37/5.7%)					

<i>n</i>	150 (92)	244 (93.8)	221 (96.5)	615 (94.3)	
mean (SD)	7.47 (2.71)	7.52 (2.57)	7.65 (2.43)	7.56 (2.55)	
Median	7.1	7	7.3	7.1	0.48
Q1/Q3	5.68/8.8	5.7/8.84	6/9	5.8/8.9	
Preoperative platelets (K/cumm) (missing: 39/6%)					
<i>n</i>	150 (92)	244 (93.8)	219 (95.6)	613 (94)	
mean (SD)	265 (102)	256 (91)	267 (95)	262 (95.42)	
Median	253	247	258	252	0.59
Q1/Q3	203/301	195/301	206/304	201/301	
Preoperative serum albumin (g/dL) (missing: 243/37.3%)					
<i>n</i>	112 (68.7)	164 (63.1)	133 (58.1)	409 (62.7)	
mean (SD)	3.83 (0.57)	3.91 (0.53)	3.89 (0.62)	3.88 (0.57)	0.50
Median	3.9	4	4	4	
Q1/Q3	3.5/4.3	3.6/4.3	3.6/4.3	3.6-4.3	
Preoperative blood urea nitrogen (mg/dL) (missing: 77/11.8%)					
<i>n</i>	149 (91.4)	231 (88.8)	195 (85.2)	575 (88.2)	
mean ± SD	14.67 (4.89) 14.99 (4.74)	15.32 (8.55)	14.17 (6.20)	14.8 (7.96)	
Median	13	14	13	14	0.18
Q1/Q3	10/16.4	11/17	10/17.7	10/17	

MBP + OAB: Mechanical bowel preparation with oral antibiotics; MBP: Mechanical bowel preparation; OAB: Oral antibiotics; *n*: Number (%) of patients with available data; ASA: American Society of Anesthesiologists; Other: Hispanic, Asian and other; No Prep: No preparation; CPT codes 44140: Colectomy, partial, with anastomosis; 44145: Colectomy, partial, with coloproctostomy (low pelvic anastomosis); 44160: Colectomy, partial, with removal of terminal ileum with ileocolostomy; 44204: Laparoscopy, surgical, colectomy, partial, with anastomosis; 44205: Laparoscopy, surgical, colectomy, partial, with removal of terminal ileum with ileocolostomy; 44207: Laparoscopy, surgical, colectomy, partial, with anastomosis, with coloproctostomy (low pelvic anastomosis). Kruskal-Wallis test was used for continuous variables; χ^2 test was used for categorical variables.

multicenter retrospective controlled trial with 1345 patients, which showed no significant difference in the rate of anastomotic leaks between patients who received MBP ($n = 670$) and those who did not receive bowel preparation ($n = 684$). Another retrospective controlled trial with 1343 participants yielded similar results and it was published by Jung *et al*^[7]. Furthermore, a randomized controlled trial by Bucher *et al*^[13] found significant adverse effects associated with MBP, *e.g.*, loss of superficial mucus and inflammatory changes (polymorphonuclear and lymphocytes cells infiltration). Finally, there have also been several case reports of bowel preparation associated adverse effects, such as electrolyte abnormalities (hyponatremia, hypernatremia, hypocalcemia, hyperphosphatemia, *etc.*) and seizures^[14-17]. On the other hand, combination therapy with oral AB and MBP seems to be beneficial for patients undergoing an elective colorectal operation according to the more recent observational database studies. Specifically, Scarborough *et al*^[8] performed an analysis of ACS-NSQIP Colectomy-Targeted datasets and found a significantly lower incidence of anastomotic leakage (MBP/OAB: 2.8% *vs* No Preparation: 5.7%, $P = 0.001$), a lower procedure related hospital readmission (MBP/OAB: 5.4% *vs* No Preparation: 7.9%, $P = 0.03$), and a lower thirty-day incidence of postoperative incisional surgical site infection (MBP/OAB: 3.2% *vs* No Preparation: 9.0%, $P < 0.001$) in patients who had received MBP and OAB compared to those who did not^[8]. Also, Kiran *et al*^[11] performed an analysis of ACS-NSQIP dataset in 2012 and found that MBP with OAB was associated with a reduced rate of anastomotic leak compared with the no preparation group.

Undoubtedly there are several notable limitations in our study, both in the database construction and in the data extraction. First, we were not able to distinguish which types of MBP or antibiotics were used. Both are significant, as different preparations have different adverse effects profiles and certain antibiotics have been associated with the development of very serious complications such as pseudomembranous colitis, which can impact complication management. Secondly, we cannot verify whether all patients received antibiotics as a prophylactic measure or due to a concurrent infection. This has the potential to radically impact our hypothesis and study findings, as some patients could have been in an inflammatory state prior to the operation. However, there were no statistically significant differences in the preoperative white blood cell counts among the three bowel preparation groups, an indication that went along well with our hypothesis of patients receiving the antibiotics primarily as a prophylactic measure rather than for a concurrent preoperative infection. Furthermore, we are not able to confirm the exact

Table 2 Univariable logistic regression analyses to identify factors associated with reoperation as a treatment for postoperative anastomotic leak (*n* = 652)

Variable	Univariable logistic regression model			P-value
	NWAD	uOR	95%CI	
Bowel Prep groups				
MBP <i>vs</i> MBP + OAB ¹	652 (100)	1.14	0.77-1.70	0.51
Nothing <i>vs</i> MBP ¹		1.23	0.86-1.76	0.25
Nothing <i>vs</i> MBP + OAB ¹		1.41	0.94-2.11	0.10
Age < 65 <i>vs</i> ≥ 65 yr ¹	649 (99.5)	0.82	0.60-1.12	0.21
BMI ≥ 30 <i>vs</i> < 30 ¹	650 (99.7)	1.44	1.03-2.00	0.03
Female <i>vs</i> male	652 (100)	1.35	0.99-1.85	0.06
Non-White <i>vs</i> White	652 (100)	1.08	0.76-1.53	0.69
No DM <i>vs</i> DM ¹	652 (100)	0.85	0.55-1.31	0.46
No steroid <i>vs</i> steroids ¹	652 (100)	0.89	0.54-1.49	0.67
Hct (%) < 38 <i>vs</i> ≥ 38 ¹	622 (95.4)	0.93	0.67-1.29	0.68
WBC (K/cumm) ≤ 12 <i>vs</i> > 12 ¹	615 (94.3)	1.53	0.74-3.16	0.26
PLT (K/cumm) < 150 <i>vs</i> ≥ 150 ¹	613 (94)	1.58	0.75-3.37	0.23
Albumin (g/dL) < 3.5 <i>vs</i> ≥ 3.5 ¹	409 (62.7)	1.13	0.70-1.83	0.62
BUN (mg/dL) > 20 <i>vs</i> ≤ 20 ¹	575 (88.2)	1.17	0.73-1.88	0.53

NWAD: Number (%) of patients with available data; uOR: Unadjusted odds ratio; MBP: Mechanical bowel preparation; OAB: Oral antibiotics; BMI: Body mass index; DM: Diabetes mellitus; Hct: Hematocrit; WBC: White blood cells; PLT: Platelets; BUN: Blood urea nitrogen; OR: Odds ratios.

¹Preoperative.

order of MBP and AB administration in patients. Finally, this study is subjected to all potential limitations and bias that a retrospective study could have.

Our study constitutes the first report concerning the association between bowel preparation and anastomotic leak treatment (for malignant and non-malignant cases). Although we did not find an advantageous impact of the bowel preparation on anastomotic leakage treatment, a prospective controlled trial with the same query would be a more reliable source to draw stronger conclusions on this topic. However, with the findings of this study we think that the clinical decision on the further treatment of anastomotic leak should not be influenced by the patient's preoperative bowel preparation.

Table 3 Baseline characteristics of patients undergoing elective colorectal resection, categorized based on anastomosis leak management

	Anastomosis leak treatment groups			P-value
	Non-surgical (n = 300)	Reoperation (n = 352)	Total (n = 652)	
Age				
NWAD (%)	300 (100)	349 (99.1)	649 (99.5)	0.89 ¹
mean ± SD	59.38 ± 15.1	59.57 ± 14.31	59.48 ± 14.67	
Median (range) Q1/Q3	61 (19-88) 50/71	60 (21-89) 51/70	61 (19-89) 50/71	
Height (inches)				
NWAD (%)	298 (99.3)	352 (100)	650 (99.7)	0.19 ¹
mean ± SD	66.39 ± 4.02	66.8 ± 3.68	66.61 ± 3.84	
Median (range) Q1/Q3	66.5 (54-80) 64/69	67 (57-76) 64/70	67 (54-80) 64/69	
Weight (lbs)				
NWAD (%)	299 (99.7)	352 (100)	651 (99.8)	0.02 ¹
mean ± SD	176 ± 44.29	186 ± 51.7	182 ± 48.65	
Median (range) Q1/Q3	172 (95-360) 144/201	179 (83-469) 149/217	175 (83-469) 145/208	
BMI				
NWAD (%)	298 (99.3)	352 (100)	650 (99.7)	0.13 ¹
mean ± SD	27.99 ± 5.79	29.34 ± 7.89	28.72 ± 7.04	
Median (range) Q1/Q3	27.12 (17.1-48.8) 23.9/31.3	28.1 (13.4-68.2) 23.9/33.3	27.75 (13-68) 23.9-32.15	
Gender				
Female	137 (45.7)	135 (38.4)	272 (41.7)	0.06 ²
Male	163 (54.3)	217 (61.6)	380 (58.3)	
Race				
White	220 (73.3)	263 (74.7)	483 (74.1)	0.69 ²
Non-White	80 (26.7)	89 (25.3)	169 (25.9)	
DM				
Yes	48 (16)	49 (13.9)	97 (14.9)	0.46 ²
No	252 (84)	303 (86.1)	555 (85.1)	
Steroids use				
Yes	32 (10.7)	34 (9.7)	66 (10.1)	0.67 ²
No	268 (89.3)	318 (90.3)	586 (89.9)	
ASA Score				
≤ 2	133 (44.3)	151 (42.9)	284 (43.6)	0.71 ²
≥ 3	167 (55.7)	201 (57.1)	368 (56.4)	
Weight loss >10%				
Yes	13 (4.3)	22 (6.3)	35 (5.4)	0.28 ²
No	287 (95.7)	330 (93.7)	617 (94.6)	
PRTR				
No	300 (100)	346 (98.3)	646 (99.1)	0.03 ³
Yes	0 (0)	6 (1.7)	6 (0.9)	

¹Mann-Whitney *U* test,² χ^2 test,³Fisher's Exact test. BMI: Body mass index; DM: Diabetes mellitus; NWAD: Number (%) of patients with available data; ASA: American Society of Anesthesiologists; PRTR: Preoperative transfusion > 4 PRBCs in 72 h before surgery.

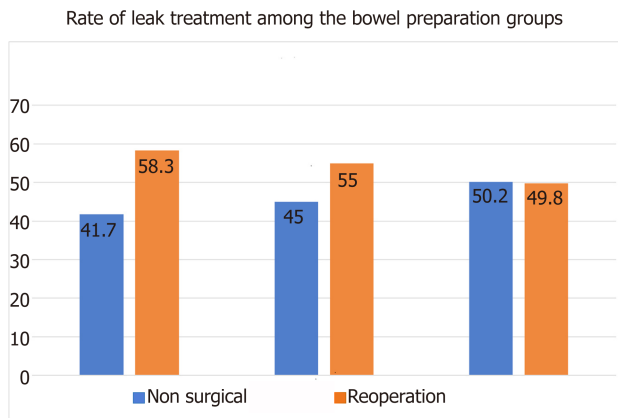


Figure 2 Rate of patients who underwent surgical treatment for the anastomotic leak among the three groups of bowel preparation. MBP: Mechanical bowel preparation.

ARTICLE HIGHLIGHTS

Research background

Controversy exists regarding the impact of preoperative bowel preparation on patients undergoing colorectal surgery. This is due to previous research studies, which fail to demonstrate protective effects of mechanical bowel preparation against postoperative complications.

Research motivation

However, in recent studies, combination therapy with oral antibiotics (OAB) and mechanical bowel preparation seems to be beneficial for patients undergoing an elective colorectal operation.

Research objectives

We aimed to determine the association between preoperative bowel preparation and postoperative anastomotic leak management (surgical *vs* non-surgical). We hypothesized that patients experiencing anastomotic leaks, following preoperative bowel preparation, would less likely require reoperation for the leak management.

Research methods

We performed a retrospective analysis of patients who had a colorectal resection with anastomosis creation and subsequently developed anastomotic leak. Every patient was assigned to one of three following groups based on the type of preoperative bowel preparation: first group-mechanical bowel preparation in combination with OAB, second group-mechanical bowel preparation alone, and third group-no preparation.

Research results

There was no statistically significant difference between the three groups of bowel preparation in terms of reoperation for anastomotic leak management.

Research conclusions

The implementation of mechanical bowel preparation and antibiotic use in patients who are going to undergo a colon resection does not influence the treatment of any possible anastomotic leakage.

Research perspectives

With the findings of this study we think that the clinical decision on the further treatment of anastomotic leak should not be influenced by the patient's preoperative bowel preparation.

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