Laparoscopic colon resection: To prep or not to prep? Analysis of 1535 patients

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Abstract

Background

Mechanical bowel preparation (MBP) before elective open colon resection does not reduce the rate of postoperative anastomotic leakage. However, MBP is still routinely used in many countries, and there are very limited data regarding the utility of preoperative MBP in patients undergoing laparoscopic colon resection (LCR). The aim of this study was to challenge the use of MBP before elective LCR.

Methods

It is a retrospective analysis of a prospectively collected database. All patients undergoing elective LCR with primary anastomosis and no stoma were included. Preoperative MBP with polyethylene glycol solution was used routinely between April 1992 and December 2004, and then it was abandoned. The early postoperative outcomes in patients who had preoperative MBP (MBP group) and in patients who underwent LCR without preoperative MBP (No-MBP group) were compared.

Results

From April 1992 to December 2014, 1535 patients underwent LCR: 706 MBP patients and 829 No-MBP patients. There were no differences in demographic data, indication for surgery and type of procedure performed between MBP and No-MBP group patients. The incidence of anastomotic leakage was similar between the two groups (3.4 vs. 3.6 %, p = 0.925). No differences were observed in intra-abdominal abscesses (0.6 vs. 0.8 %, p = 0.734), wound infections (0.6 vs. 1.4 %, p = 0.149), infectious extra-abdominal complications (1.8 vs. 3 %, p = 0.190), and non-infectious complications (6.1 vs. 6.8 %, p = 0.672). The overall reoperation rate was 4.6 % for MBP patients and 5 % for No-MBP patients (p = 0.813).

Conclusion

The use of preoperative MBP does not seem to be associated with lower incidence of intra-abdominal septic complications after LCR.

Keywords

Mechanical bowel preparation Laparoscopy Colon Anastomotic leakage Morbidity

Mechanical bowel preparation (MBP) before colorectal surgery has been considered for many decades as one of the most important factors to decrease the risk of postoperative anastomotic leakage and infectious complications [1].
Randomized controlled trials (RCTs) [2–13] and meta-analyses [14] have shown that MBP before elective open colon resection does not lead to lower rates of postoperative anastomotic leakages and septic complications, suggesting that it should be omitted. However, preoperative MBP is still routinely used in many countries [15–19].
To date, it is not clear whether the results reported after open colon surgery can be extrapolated to LCR [20]. Data regarding the effects of preoperative MBP in patients undergoing elective laparoscopic colon resection (LCR) are very limited. Only a few and small underpowered studies have focused on the postoperative outcomes in selected patients undergoing LCR with or without MBP [21, 22].
The aim of this study was to challenge the use of MBP before elective LCR with primary anastomosis, comparing the early postoperative outcomes in patients who had undergone LCR with or without preoperative MBP.

Methods

This study is a retrospective analysis of a prospectively collected database. All patients referred for elective LCR for benign or malignant colon disease localized above the peritoneal reflection at our institution from April 1992 through December 2014 were identified. Patients undergoing a procedure involving a stoma creation were excluded.
Preoperative MBP was used routinely between April 1992 and December 2004 (MBP group), and then according to the results of the meta-analysis by Slim et al. [23], it was abandoned (No-MBP group). MBP consisted of polyethylene glycol solution (4 L 48 h before surgery). MBP patients had then a fluid diet. No-MBP patients had no dietary restrictions; patients undergoing left-sided resection had enema before LCR.
Perioperative management was standardized. No patients received preoperative oral antibiotics. Intravenous antibiotics (cephalosporin or gentamycine in patients allergic to cephalosporin and metronidazole) were administered before starting LCR. Deep venous thrombosis prophylaxis was achieved with subcutaneous injection of low molecular weight heparin and pneumatic compression stockings.
All LCRs were performed by two surgeons (MM and MD) who had extensive experience in colorectal and laparoscopic advanced surgery. During right hemicolectomy, the bowel specimen was extracted through a transverse incision with the use of a wound protector, and an extracorporeal end-to-end hand-sewn or side-to-side stapled anastomosis was performed. During left hemicolectomy, sigmoidectomy, and Frykman–Goldberg operation, the specimen was removed through a small suprapubic transverse incision, and the anastomosis was performed by laparoscopic transanal intracorporeal stapled technique. Conversion to open surgery was defined as an unplanned incision or an incision made longer or earlier than planned.
A prospective protocol was designed to evaluate the following parameters: patient's characteristics, indication for surgery, operative variables, and short-term (within 30 days from surgery) morbidity according to Dindo [24]. Operative variables included type of resection, operative time, blood losses, need for intraoperative colonoscopy and conversion rate.
Postoperative morbidity included anastomotic (anastomotic leakage), infectious and non-infectious (intra-abdominal and extra-abdominal) complications. Infectious complications comprised both surgical site infections (intra-abdominal abscess and wound infection), and non-surgical site infectious complications, such as respiratory and urinary tract infections.
The primary endpoint of this study was the rate of symptomatic anastomotic leakage. In case of clinical suspicion of anastomotic leakage (fever, signs of local or generalized peritonitis, discharge

of gas, pus or stools from the drainage tube), patients underwent a CT scan to confirm the diagnosis. Patients were not screened for asymptomatic leakage.
Secondary endpoints were infectious and non-infectious (intra-abdominal and extra-abdominal) complications and mortality.

Statistical analysis

Quantitative data are given as median and range, and categorical data are expressed as percentages. Statistical analysis among the groups was performed using χ^2 test or the Student's t test as appropriate.
All analyses were performed on an "intention-to-treat" basis: patients converted to an open procedure were included in the study. All p values were two-sided. A level of 5 % was set as the criterion for statistical significance. The data were collected in an Excel spreadsheet. The statistical analysis was performed using SPSS version 19 (Copyright © SPSS Inc., 2000).

Results

Between April 1992 and December 2014, 1535 patients underwent elective LCR with primary anastomosis with no diverting stoma.
A total of 706 patients had preoperative MBP (MBP group) and 829 patients had no preoperative MBP (No-MBP group). No differences were observed between the two groups in age, gender, body mass index, American Society of Anesthesiologists (ASA) score and indication for LCR (Table 1). An adenoma or carcinoma was the preoperative diagnosis in 565 MBP and 658 No-MBP patients. Mean tumor size and pT staging distribution were similar in the two groups (Table 1).
Table 1
Patients' characteristics

	MBP (n = 706)	**No-MBP (n = 829)**	**p value**
Gender			
Male	361 (51.1)	432 (52.1)	0.741
Age, years (range)	65 (18–92)	66 (20–92)	0.260
Body mass index, kg/m^2 (range)	25 (18–33)	24 (19–31)	0.611
ASA score			0.307
I	240 (34)	256 (30.9)	
II	297 (42.1)	340 (41)	
III	159 (22.5)	223 (26.9)	
IV	10 (1.4)	10 (1.2)	
Indications for LCR			0.283
Cancer	503 (71.2)	561 (67.7)	
Adenoma	62 (8.8)	97 (11.7)	
Diverticulitis	116 (16.4)	148 (17.9)	
Reversal of Hartmann's procedure	18 (2.6)	16 (1.9)	
Rectal prolapse	7 (1)	7 (0.8)	
pT staging[a]			1
1	97 (19.3)	107 (19.1)	
2	79 (15.7)	84 (14.9)	
3	289 (57.5)	318 (56.7)	
4	38 (7.5)	52 (9.3)	

	MBP (n = 706)	No-MBP (n = 829)	p value
Tumor size, cm (range)[b]	3 (1–10)	4 (1–9)	0.498

Values in parentheses are percentages unless indicated otherwise
MBP mechanical bowel preparation, ASA American Society of Anesthesiologist, LCR laparoscopic colon resection
[a]Cancer patients, [b] cancer + adenoma patients
A preoperative endoscopic tattooing of the colon neoplasm at the time of the diagnostic colonoscopy was obtained in 47 (8.3 %) of the 565 neoplastic MBP patients and in 142 (21.6 %) of the 658 neoplastic No-MBP patients ($p < 0.001$).

Intraoperative results

The type of procedure and the type of anastomosis performed are reported in Table 2.
Table 2
Intraoperative results

	MBP (n = 706)	No-MBP (n = 829)	p value
Procedure			0.640
Right hemicolectomy	203 (28.8)	266 (32.1)	
Left hemicolectomy	344 (48.7)	390 (47.1)	
Sigmoidectomy	134 (19)	150 (18.1)	
Reversal of Hartmann's procedure	18 (2.5)	16 (1.9)	
Frykman–Goldberg operation	7 (1)	7 (0.8)	
Type of anastomosis			0.594
Stapled	655 (92.8)	762 (91.9)	
Hand-sewn	51 (7.2)	67 (8.1)	
Conversion	81 (11.5)	81 (9.8)	0.318
Locally advanced tumor	50 (61.7)	42 (51.9)	
Obesity	9 (11.1)	14 (17.3)	
Adhesions	15 (18.5)	17 (20.9)	
Intraoperative complications	4 (4.9)	2 (2.5)	
Technical problems	2 (2.5)	5 (6.1)	
Inability to visualize the tumor	1 (1.3)	1 (1.3)	

Values in parentheses are percentages unless indicated otherwise
MBP mechanical bowel preparation
An intraoperative colonoscopy was necessary to identify the neoplasm in 67 (11.9 %) neoplastic MBP patients and in 8 (1.2 %) neoplastic No-MBP patients ($p < 0.001$).
Overall, median operative time was 140 (range 50–310) min in the MBP group and 120 (range 60–300) min in the No-MBP group ($p = 0.257$). Median estimated blood loss was 100 (range 10–800) ml in the MBP group and 80 (range 10–400) ml in the No-MBP group ($p = 0.301$).
No significant differences were observed in the conversion rate to open surgery between the two groups: 11.5 versus 9.8 % ($p = 0.318$). Main causes of conversion were locally advanced cancer, adhesions, and morbid obesity in both groups of patients. The inability to localize the tumor led to conversion to open surgery in one cancer patient in each group (a 3-cm T3 left colon cancer in the MBP group and a 5-cm T3 transverse colon cancer in the No-MBP group) (Table 2).

Postoperative results

The first bowel movement occurred on postoperative day 3 (range 2–16) in the MBP group and on postoperative day 4 (range 2–23) in the No-MBP group (p = 0.278). No differences were observed in resumption of solid diet: 4 (range 2–16) days in the MBP group and 4 (range 2–28) days in the No-MBP group (p = 0.331). Median postoperative length of stay was similar in the two groups: 7 (range 4–98) days in the MBP group and 7 (4–99) days in the No-MBP group (p = 0.296).
The severity of complications according to the Dindo classification was similar between the two groups (Table 3). Mortality rate was 0.71 % among MBP patients (two cases due to bowel infarction, two cases due to respiratory failure, and one case due to sepsis secondary to anastomotic leakage) and 0.72 % among No-MBP patients (three cases due to respiratory failure, two cases due to sepsis secondary to anastomotic leakage, and one case due to cardiac attack) (p = 0.789).
Table 3
Postoperative morbidity

	MBP (n = 706)	**No-MBP (n = 829)**	**p value**
Grade 1	9 (1.3)	18 (2.2)	0.256
Grade 2	30 (4.2)	49 (5.9)	0.176
Grade 3	42 (5.9)	55 (6.6)	0.656
3a	9 (1.3)	13 (1.6)	0.790
3b	33 (4.6)	42 (5)	0.813
Grade 4	2 (0.3)	2 (0.2)	0.733
4a	2 (0.3)	2 (0.2)	0.733
4b	0	0	
Grade 5	5 (0.71)	6 (0.72)	0.789

Values in parentheses are percentages unless indicated otherwise
MBP mechanical bowel preparation
The incidence of postoperative anastomotic leakage was similar between the two groups: 3.4 % (24 MBP patients) and 3.6 % (30 No-MBP patients), respectively (p = 0.925). Clinical presentation was similar in the two groups, with a reoperation for postoperative anastomotic leakage that was needed in 19 (79.2 %) of the 24 MBP patients and in 27 (90 %) of the 30 No-MBP patients (p = 0.443). Similar intra-abdominal abscess rates were observed in the two groups: 0.6 % (4 MBP patients) versus 0.8 % (7 No-MBP patients) (p = 0.734). A reoperation to treat intra-abdominal abscesses not amenable to percutaneous drainage was performed in one out of four (25 %) MBP patients and in two out of seven (28.6 %) No-MBP patients (p = 0.565).
There were no significant differences in wound infections (0.6 vs. 1.4 %, p = 0.149) and infectious extra-abdominal complication rates (1.8 vs. 3 %, p = 0.190) between MBP and No-MBP patients. No differences were observed in urinary tract infections [0.3 % (2 patients) in the MBP group and 0.4 % (3 patients) in the No-MBP group, p = 0.857] and in pneumonia [1.5 % (11 patients) in the MBP group and 2.6 % (22 patients) in the No-MBP group, p = 0.194].
Non-infectious complications occurred in 43 (6.1 %) MBP patients and 56 (6.8 %) No-MBP patients (p = 0.672).
The 30-day overall reoperation rate was 4.6 % for MBP patients and 5 % for No-MBP patients (p = 0.813). Table 4 summarizes the reasons for a reoperation.
Table 4
Reoperations

	MBP (n = 706)	**No-MBP (n = 829)**	**p value**
Total	33 (4.6)	42 (5)	0.813
Anastomotic leakage	19 (2.7)	27 (3.3)	0.619
Intraabdominal abscess	1 (0.1)	2 (0.2)	0.889
SBO	3 (0.4)	4 (0.5)	0.831
Small bowel perforation	4 (0.6)	1 (0.1)	0.281

	MBP (n = 706)	No-MBP (n = 829)	p value
Hemoperitoneum	5 (0.7)	6 (0.7)	0.789
Bowel infarction	1 (0.1)	0	0.936
Evisceration	0	2 (0.2)	0.551

Values in parentheses are percentages unless indicated otherwise
MBP mechanical bowel preparation, SBO small bowel obstruction

Adjuvant chemotherapy was administered to 352 (70 %) MBP cancer patients and to 426 (72 %) No-MBP cancer patients (p = 0.508). During the follow-up, one (0.3 %) anastomotic leakage occurred in the MBP group and one (0.2 %) in the No-MBP group (p = 0.565).

Discussion

Preoperative MBP has been a surgical dogma for many decades in the assumption that it reduces the incidence of anastomotic leakage and infectious complications after elective colon resection by reducing the colonic bacterial load [1]. However, it has been demonstrated that MBP leads to changes in bowel microflora balance [25] without affecting the intramucosal bacterial colony count [26].

Several RCTs published between 1992 and 2007 [2–13] have demonstrated similar short-term outcomes in patients undergoing open colon resection with or without preoperative MBP, suggesting that preoperative MBP should be omitted before colon surgery. Nevertheless, MBP is still used in the routine clinical practice in many centers before both open and laparoscopic colon surgery [15–19]. For instance, Drummond et al. [16] conducted a survey among 198 members of the Association of Coloproctology of GB and Ireland. LCR was routinely performed by 95 (48 %) surgeons. The responses to the questionnaire showed a trend toward a higher use of full MBP before laparoscopic than open right hemicolectomies (16.8 vs. 9.5 %, p = 0.08) and a lower percentage of surgeons performing laparoscopic right hemicolectomies with no MBP compared to open right hemicolectomies (68.4 vs. 79.4 %, p = 0.042). Furthermore, similar proportions of surgeons were still using MBP before elective open or laparoscopic left hemicolectomy (43.4 and 40.2 %, respectively). Interestingly, 13.6 % of surgeons declared changes in their practice when shifting from open to laparoscopic right hemicolectomy, with some changing from no preparation to full MBP and others changing from no MBP to enemas. Eleven percent of surgeons reported similar changes in their MBP regimens for patients undergoing laparoscopic left hemicolectomy. Similar data were published by Slieker et al. [19] who conducted an online survey to assess the current practice of Dutch surgeons concerning the use of MBP before LCRs.

MBP is still used before LCR for several reasons: (a) changing practice by challenging a dogma is difficult; (b) the accurate tumor localization is limited by the inability to palpate the colon during LCR; and (c) there are only a few small studies assessing specifically the impact of MBP on early postoperative morbidity in patients undergoing LCR [21, 22]. For instance, Zmora et al. [22] analyzed retrospectively the outcomes in 200 patients undergoing laparoscopic colon and rectal resection for both benign and malignant colorectal tumors: 68 (34 %) had preoperative MBP and 132 (66 %) had no preoperative MBP. There were no significant differences in the rate of intraoperative colonoscopy performed to localize the tumor (9 vs. 8 %, p = 0.78). Conversion to open surgery was due to inability to localize the tumor only in one patient who had no preoperative MBP. Similar rates of anastomotic leakage (4 and 3 %, p = 0.69) and wound infections (12 vs. 17 %, p = 0.41) were observed. The authors concluded that the omission of MBP before LCR was not safe in patients with small tumors which were not marked by preoperative tattooing. However, these conclusions are limited by the fact that the study was underpowered to detect clinically significant differences in the complication rate and small lesions were excluded from the analysis.

We reviewed the short-term outcomes in 1535 patients (706 MBP patients and 829 No-MBP patients) undergoing LCR with primary anastomosis and no diverting stoma. The severity of complications according to Dindo classification was similar in the two groups, with no differences in the rate of postoperative anastomotic leakage, intra-abdominal abscesses, wound infections, and infectious extra-abdominal complications. These results are consistent with those reported in the two largest RCTs published on open colon surgery [12, 13], showing that MBP is not associated with reduced risk of both intra-abdominal and extra-abdominal infectious complications. In addition, MBP did not reduce the need for reoperation for anastomotic leakage or intra-abdominal abscesses, reflecting the fact that MBP does not affect the intramucosal bacterial colony count [26].
The last few decades have witnessed the development of laparoscopic colon surgery and a significant rise in the detection of early colon cancers secondary to the widespread introduction of population-based screening programs. The laparoscopic approach is characterized by loss of tactile sensation that makes the intraoperative identification of colon tumors more challenging than open surgery. Several methods to localize colon tumors have been developed, including intraoperative colonoscopy and preoperative endoscopic tattooing. Recent studies have shown that intraoperative colonoscopy is safe and does not affect intraoperative and postoperative outcomes [27]. However, intraoperative colonoscopy requires an expert endoscopist or a surgeon experienced in endoscopy, may reduce the operative exposure due to colon insufflation and result in increased operative times [28]. In addition, preoperative bowel cleansing by MBP is necessary for an accurate intraoperative endoscopic colon exploration. Preoperative endoscopic tattooing is a safe and effective method for the localization of colon lesions during both open and LCR, with very low complication rates and accuracy rates ranging between 88 and 100 % [29–31].
We observed a shift in our practice between the MBP and the No-MBP period: while the number of intraoperative colonoscopy significantly decreased (from 11.9 to 1.2 %), the number of endoscopic tattooing performed during the diagnostic colonoscopy significantly increased (from 8.3 to 21.6 %). The inability to intraoperatively visualize the colon tumor led to conversion to open surgery in one 3-cm left-sided T3 cancer patient in the MBP group and in one 5-cm transverse colon cancer in the No-MBP group. Both patients did not undergo preoperative tattooing, and intraoperative colonoscopy was not performed for technical reasons. These results show that the LCR with no preoperative MBP is not associated with an increased risk of conversion due to inability to visualize the tumor, and therefore MBP can be safely omitted also in patients with small tumors.
We acknowledge that this study has some limitations. First, it is retrospective over a long period of time; second, it is a single-institution study and all surgical procedures were performed by two very experienced surgeons. Therefore, our findings may not be generalized. However, this is the largest study assessing the short-term outcomes in patients undergoing LCR with or without preoperative MBP, and it is powered to detect possible significant differences in the anastomotic leakage rate. The expected anastomotic leakage rate after MBP was 5 % according to previous studies [13], and allowing a difference of 3 % as the non-inferiority margin, a sample size of 1400 patients was needed to prove this difference (α set at 0.05; β set at 0.2; power = 80 %). Furthermore, no significant changes in surgical techniques and hospital care occurred during the two time periods of the study. Therefore, we feel that the results of this large study will contribute to the implementation of the omission of MBP in the preoperative management of patients undergoing elective LCR for both benign and malignant colonic diseases.
In conclusion, the results of this study show similar rates of anastomotic leakage and intra-abdominal or extra-abdominal infectious complications after LCR with or without MBP, thus suggesting that MBP is optional even before LCR.

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