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SURGICAL ENDOSCOPY
and Other Interventional Techniques

Gastrointestinal transit after laparoscopic vs open colonic resection

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Abstract
Background: Multimodal rehabilitation with epidural analgesia, early oral nutrition and mobilization, and laxative use has decreased the duration of ileus after colonic surgery to about 2 days, as compared with the usual 3 to 5 days of rehabilitation required after open surgery and the slightly shorter time required with laparoscopic surgery. Gastrointestinal transit after colonic resection with laparoscopy or laparotomy was assessed.
Methods: In this study, 32 patients randomized to laparoscopic or open colonic resection received 4 MBq of ^{111}indium diethylenetriamine pentaacetic acid, a tracer, at the end of surgery. Images of the abdomen were obtained 24 and 48 h postoperatively. An opaque abdominal dressing blinded care personnel and patients to the procedure.
Results: Defecation occurred on median day 2 postoperatively in both groups. At 48 h postoperatively, 53% of the tracer was excreted by patients in the laparoscopic group, as compared with 26% in the open group ($p > 0.05$).
Conclusion: Postoperative ileus and gastrointestinal transit normalized within 48 h after colonic resection in the patients who received multimodal rehabilitation. No significant difference was observed between the patients who underwent the laparoscopic procedure and those who underwent the open procedure.

Key words: Gastrointestinal transit — Colon — Surgery — Laparoscopy — Standard care

Colonic resection usually is associated with postoperative ileus for 3 to 5 days [8], which may be slightly shorter with the laparoscopic approach [5, 6, 9, 10]. Introduction of a multimodal rehabilitation program with continuous thoracic epidural analgesia, early oral nutrition and mobilization, the use of laxatives, and a planned 2-day postoperative hospital stay has in preliminary studies shortened the ileus to about 48 h after both open [3] and laparoscopic resection [1, 11]. However, most studies have assessed the ileus by rather simple measures such as return of bowel sounds and time to first flatus or defecation. The aim of this study was to assess in more detail the entire gastrointestinal transit rate using a scintigraphic technique [4] for patients randomized to laparoscopic as compared with open colonic resection using multimodal rehabilitation.

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Patients and methods

This was a consecutive, prospective, randomized, blinded study. Patients undergoing elective right hemicolectomy or sigmoid resection between May 18, 1999 and May 30, 2001 were included in the study. Exclusion criteria specified acute or subacute operation, age of 55 years or less, psychiatric disease, inability to insert an epidural catheter, the presence of a stoma, the need for surgery in an addition to the resection, or an anastomosis less than 12 cm from the anus. Finally, patients were excluded who underwent surgery during the summer or on national holidays, when the research team was not available. Sealed envelopes were used for randomization to laparoscopically assisted or open techniques. The indication for surgery was established in the outpatient clinic.

The bowel preparation and anesthesia were standardized and similar in the two groups, as described previously in the literature [3]. One surgeon (L. Bardram) performed the laparoscopic procedures, and another surgeon (P.B.) performed or supervised the open procedures. A surgeon from the research team (L. Basse) and nurses provided postoperative care. An opaque dressing on the abdomen blinded all the participants in the study to the surgical approach until the patients were discharged. The incision was not inspected until discharge was scheduled. All the patients were treated with a well-defined postoperative multimodal rehabilitation program, including continuous thoracic epidural analgesia for 48 h. The patients in the laparoscopic group received bupivacaine 0.25% 4 ml/h, and the patients in the open group, received bupivacaine 0.25% 4 ml/h plus 0.2 mg of morphine per hour, the standard epidural analgesia in our department. Nasogastric tubes were not used. Patients received early oral nutrition and mobilization and a laxative with magnesium oxide from the day of

surgery. A 2-day hospital stay was planned for each patient [1, 3]. The discharge criteria were tolerance of normal oral diet, defecation, and sufficient pain relief with oral analgesics during mobilization.

The gastrointestinal transit was assessed by means of a gamma camera technique described earlier [4]. Data from the first 10 patients in the open group were included in this methodological study [4]. At the end of the surgical procedure, a liquid tracer, 4 MBq of ^{111}indium diethylenetriamine pentaacetic acid (^{111}In-DTPA) was injected into the stomach via a nasogastric tube. The nasogastric tube was removed at once. Abdominal images were obtained 24 and 48 h postoperatively. Images of the collected emesis and stool for periods of 24 h also were obtained. The percentage distribution of tracer in emesis, abdominal regions of interest, and stools was computed from the total amount of radioactivity after 24 and 48 h. The geometric center was calculated as the segment number (1 = ascending and transverse colon, 2 = descending colon, 3 = sigmoid colon and rectum, 4 = feces), in which 50% of the radioactivity lay on either side. Thus, the higher the segment number, the faster the colonic transit [4].

Sample size was estimated empirically to 32 patients on the basis of the only study available on the scintigraphy method used for colonic surgery [4]. Clinical studies with multimodal rehabilitation after open [2, 3, 12] and laparoscopic [1, 11] surgery have suggested defecation within 48 h for more than 90% of patients, calling for a sample size exceeding 400 patients in a comparative study, which was unrealistic for the scintigraphic technique.

The local ethics committee approved the study, and written informed consent was obtained before the study began. Values are presented as medians with ranges. The Mann–Whitney test was used to analyze statistical differences between groups. The statistical level of significance was set at p values less than 0.05.

Results

For this study, 42 patients were randomized. Subsequently, 10 patients were withdrawn for various reasons: five were scheduled for additional surgeries, three had technical tracer problems, and two were under observation for complications (pulmonary and anastomotic leak) not permitting transfer to the scintigraphic procedure. Of the remaining 32 patients, 15 underwent laparoscopic surgery and 17 had open surgery. Demographics, distribution of surgical techniques, and procedures are shown in Table 1. The median hospital stay was 2 days (range, 2–8 days; mean, 2.7 days) in the laparoscopic group and 2 days (range, 2–5days; mean, 2.3 days) in the open group ($p > 0.05$). Patients stayed more than the planned 2 days because of emesis ($n = 1$), lack of defecation ($n = 2$), and urinary retention ($n = 1$) in the laparoscopic group, and because of low hemoglobin and need for blood transfusion ($n = 1$) and social reasons ($n = 1$) in the open group.

In the laparoscopic group, six patients defecated within 24 h; seven patients defecated between 24 and 48 h; and two patients defecated after 48 h. In the open group, 10 patients, defecated within 24 h, and the remaining 7 patients defecated between 24 and 48 h. In the laparoscopic group, three patients respectively, vomited 13%, 100%, and 100% of the tracer. In the open group, 10 patients vomited a median 37% (range, 1–100%; $p > 0.05$) of the tracer within the first 24 h. Only one patient in the open group vomited 100% of the tracer. No patient vomited tracer after 24 h. The 13 patients in the laparoscopic group with retained tracer excreted a median 53% of the tracer with feces within 48 h, and the 16 patients in the open group with retained tracer excreted a median 26% of the tracer with feces within 48 h ($p = 0.12$). There was no statistical difference in segmental distribution of tracer between the groups (Table 2). At 48 h after surgery, the geometric center was 3.08 (range, 1.24–4.00) in the laparoscopic group and 2.66 (range, 1.58–4.00; $p = 0.03$) in the open group.

Table 1. Demographics for patients undergoing laparoscopic or open colonic resection with multimodal rehabilitation[a]

	Laparoscopic $n = 15$	Open $n = 17$
Age (years) median (range)	78 (58–85)	76 (56–89)
Gender M/F	7/8	6/11
Right colectomy	8	8
Sigmoid resection	7	9
Defecation in 0–24 h	6	10
Defecation in 24–48 h	7	7
Defecation after more than 48 h	2	0
Hospital stay median (range)	2 (2–8)	2 (2–5)
No. of patients staying more than 48 h because of nausea, emesis, or lack of defecation	3	0

[a] $p > 0.05$ between groups

Complications

All the patients had follow-up evaluation for 30 days. In the laparoscopic group, one patient was transferred from the recovery room to the department of cardiology for 21 h for a suspected, but not confirmed, myocardial infarction. This patient stayed for 8 days because of paralytic ileus. One patient was treated in the outpatient clinic for superficial wound infection. One patient readmitted on day 7 for nausea and emesis stayed 2 days, and one patient readmitted on day 8 for bradycardia and electrolyte disturbances stayed for 3 days. In the open group, one patient was treated in the outpatient clinic for superficial wound infection. Four patients were readmitted: one with wound rupture on day 7, one with atrial fibrillation on day 4, one with headache on day 13, and one for social reasons on day 4 because her husband died the day after surgery. These patients stayed 1, 8, 8, and 4 days, respectively.

Discussion

In the current study, we used the ^{111}indium scintigraphic method to assess regional and entire gastrointestinal transit rates [4]. Our study is the first randomized, observer- and treatment-blinded study of gastrointestinal transit rates for patients undergoing laparoscopic or open colonic resection combined with a well-defined multimodal rehabilitation program using epidural analgesia, enforced oral nutrition and mobilization, and laxative.

The results show no statistical or clinical relevant difference in time to defecation, gastrointestinal transit rate, discharge time, or postdischarge occurrence of nausea, emesis, and ileus between the two surgical

Table 2. Distribution of ^{111}indium diethylenetriamine pentaacetic acid in the gastrointestinal tract and geometric center 24 and 48 h after administration of the tracer in patients undergoing laparoscopic or open colonic resection with multimodal rehabilitation[a]

	Laparoscopic $n = 13$ n (range)	Open $n = 16$ n (range)
24 Hours		
Vomit	0 (0–100)	10 (0–100)
Stomach	0 (0–0)	0 (0–0)
Small bowel	0 (0–54)	0 (0–0)
Ascending and transverse colon	27 (0–94)	25 (0–100)
Descending colon	17 (0–39)	16 (0–33)
Rectosigmoid	17 (0–55)	19 (0–86)
Feces	3 (0–100)	0 (0–100)
Geometric center	1.73 (0–4)	1.41 (0.48–4)
48 Hours		
Stomach	0 (0–0)	0 (0–0)
Small bowel	0 (0–49)	0 (0–0)
Ascending and transverse colon	3 (0–39)	10 (0–74)
Descending colon	3 (0–28)	13 (0–43)
Rectosigmoid	5 (0–37)	22 (0–64)
Feces	53 (0–100)	26 (0–100)
Geometric center	3.08 (0–4)	2.66 (1.58–4.00)

[a] Median and range, $p > 0.05$

techniques. Although the time to defecation was similar between the two groups, the transit rate was shorter (53% vs 26% of the tracer excreted in feces within 48 h) in the laparoscopic than in the open group, albeit this difference was not significant ($p = 0.12$). Therefore, because of the small sample size, we cannot exclude a slightly shorter duration of ileus with laparoscopy (risk of type 2 error). However, in our previous study [4], we found transit rates in patients after open colonic resection to be similar to those of normal, gastrointestinal control subjects who did not undergo surgery. These results are in contrast to the usual duration of postoperative ileus (3–5 days) after colonic surgery [8], although the duration generally is about 1 day shorter when the laparoscopic approach is used [5, 6, 9, 10] in combination with conventional care programs. On the other hand, our randomized study confirms previous preliminary nonrandomized data for about 200 patients in studies that used multimodal rehabilitation with epidural analgesia and early oral nutrition for individuals undergoing open [2, 3, 12] or laparoscopic [1, 11] colonic resection and ileus (time to defecation) was reduced to about 1 to 2 days. Our study also confirms that a revision of the overall postoperative care program [3, 7, 14] with avoidance of routinely used nasogastric tubes, use of thoracic epidural analgesia, and provision of early oral nutrition may be more effective in reducing ileus than the choice of surgical technique per se [1]. Most interestingly, institution of such a multimodal rehabilitation program, with the resulting very short duration of ileus, failed to show the additional beneficial effect of laparoscopic surgery that has been demonstrated in previous studies [5, 6, 9, 10] with conventional care.

When the results from the current study are taken together with previous data from uncontrolled observations of open [2, 3, 12] or laparoscopic [1, 11] colonic resection with multimodal rehabilitation, the data do not suggest any clinical relevant difference in the duration of ileus between the laparoscopic and the open technique combined with multimodal rehabilitation. It may be argued that the epidural regimens were different in our two groups, but this may not change the conclusions because the open group received additional epidural morphine together with bupivacaine. Thus, the addition of morphine may, if anything, retard resolution of ileus [8], but no differences between the groups were observed.

Hospital stay was not the major outcome of this study, but both groups showed a short (median, 2 days) hospital stay according to the care protocol. Readmission rates for nausea and vomiting were similar in the two groups: one patient in the laparoscopic group and no patients in the open group. Hospital stay beyond 48 h because of vomiting or lack of defecation occurred in three patients in the laparoscopic group and no patients in the open group. Obviously, large scale studies are needed to evaluate potential differences in hospital stay, readmission rates, and morbidity between the laparoscopic and open surgical techniques, but again, these outcomes may be determined merely by surgical complications and traditions included in the overall perioperative care program rather than by choice of surgical technique per se. A recent, large-size randomized study between open and laparoscopic colonic resection with traditional care showed a slightly shorter hospital stay (5–6 days) in the laparoscopic group than in the open group (6.4 days) [13].

In summary, our randomized, blinded study showed no difference in the duration of ileus or gastrointestinal transit rates between patients undergoing segmental colonic resection with the laparoscopic surgery, and those undergoing open surgery when both groups received a multimodal rehabilitation program with epidural analgesia, early oral nutrition and mobilization, and laxative treatment.

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