Diseases of the Colon & Rectum

Original Contributions

Colonic Surgery With Accelerated Rehabilitation or Conventional Care

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BACKGROUND: For patients undergoing colonic surgery, the postoperative hospital stay is usually 6 to 10 days, and the morbidity rate is 15 to 20 percent. Fast-track rehabilitation programs have reduced the hospital stay to 2 to 3 days. The aim of this study was to evaluate the postoperative outcome after colonic resection with conventional care compared with fast-track multimodal rehabilitation. METHODS: One hundred thirty consecutive patients receiving conventional care (group 1) in one hospital were compared with 130 consecutive patients receiving multimodal, fast-track rehabilitation (group 2) in another hospital. Outcomes were time to first defecation after surgery, postoperative hospital stay, and morbidity during the first postoperative month. RESULTS: Median age was 74 years (group 1) and 72 years (group 2). American Society of Anesthesiologists (ASA) score was significantly higher in group 2 ($P < 0.05$). Defecation occurred on day 4.5 in group 1 and day 2 in group 2 ($P < 0.05$). Median hospital stay was 8 days in group 1 and 2 days in group 2 ($P < 0.05$). The use of a nasogastric tube was longer in group 1 ($P < 0.05$). The overall complication rate (35 patients) was lower in group 2 ($P < 0.05$), especially cardiopulmonary complications (5 patients; $P < 0.01$). Readmission was necessary in 12 percent of cases for group 1 and 20 percent in group 2 ($P > 0.05$). CONCLUSIONS: Time to first defecation, hospital stay, and morbidity may be reduced after colonic resection with fast-track multimodal rehabilitation. [Key words: Surgery; Fast track; Rehabilitation; Postoperative; Morbidity]

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Colonic surgery is usually associated with a complication rate of 15 to 20 percent and a postoperative hospital stay of 6 to 10 days.[1–4] Introduction of a fast-track postoperative care program[5,6] may shorten hospital stay to 2 to 3 days.[7,8] Also, multimodal rehabilitation may preserve postoperative body composition, pulmonary function, and cardiovascular response to exercise.[9] However, the overall experience has been limited concerning morbidity after segmental colonic resection with multimodal rehabilitation and has not been compared with colonic resection with conventional care. Therefore, the aim of this study was to compare postoperative morbidity and hospital stay in patients undergoing colonic resection with multimodal rehabilitation or conventional care.

METHODS

From Copenhagen University Hospital in Gentofte 130 consecutive patients undergoing colonic resection with conventional care[7] (group 1) were studied retrospectively from medical record reviews between 14 January 1998 and 31 December 2000; from Copenhagen University Hospital in Hvidovre, 130 consecutive patients receiving multimodal rehabilitation[7] between April 1, 1997 until December 31, 2000 were studied prospectively. Exclusion criteria were (1) low anterior resection and rectal extirpation, (2) patients receiving a stoma, and (3) patients undergoing acute and subacute surgery. In group 2 patients undergoing surgery during the summer periods and national holi-

Table 1.
Protocol for Anesthesia, Surgery, and Rehabilitation Program After Colonic Resection With Conventional Care (Group 1) and Multimodal Rehabilitation (Group 2)

	Group 1	Group 2
Anesthesia	Premedication: oral diazepam 10 mg Epidural catheter T_8-T_{10} Carbocaine 2% (4 + 4) ml with epinephrine Carbocaine 2% 4 ml with epinephrine hourly General anesthesia Fentanyl 0.1 mg Thiomebumal 3-5 mg/kg Rocuronium O2-N2O-sevoflurane Dextran 70 (Macrodex®) 500 ml Saline 3000 ml (max)	Premedication: none Epidural catheter Right hemicolectomy: T_6-T_7 Sigmoid resection: T_9-T_{10} Test: lidocaine 2% 3 ml with epinephrine Bupivacaine 0.5% (6 + 6) ml Bupivacaine 0.25% 5 ml 2 hours intraoperatively Morphine 2 mg if < 70 year Morphine 1 mg if ≥ 70 year General anesthesia Remifentanil 1 μg/kg/min Propofol 2–4 mg/kg/h Cisatracium 0.15 mg/kg Hydroxyethyl starch (HAES®) 500 ml Saline 1,500 ml (max) Ondansetron 4 mg Ketorolac 30 mg Bupivacaine 0.25% 20 ml (incision)
Surgery	Median laparotomy	Transverse or curved incision[2]
Postoperatively	Continuous epidural analgesia (3 days): bupivacaine 0.25% 4 ml and morphine 0.2 mg hourly Breakthrough pain: morphine im or IV After removal of epidural catheter: morphine 10 mg pn orally No standard care program: fluid, food, mobilization and discharge depending on the attending surgeon Postoperative nasogastric tube depending on surgeon who performed the operation Physiotherapy: breathing exercise 10 min per day during the first 2 postoperative days and only on working days	Continuous epidural analgesia (2 days): bupivacaine 0.25% 4 ml and morphine 0.2 mg/h Breakthrough pain: ibuprofen 600 mg orally Bupivacaine 0.125% 6 ml epidurally Morphine 10 mg orally (last choice) Food, protein drink 60–80 g protein per day and mobilization from the day of surgery following a well-defined nursing care program Day of surgery start: acetaminophen (slow release) 2 g 12 hourly Magnesia 1 g 12 hourly Cisapride 20 mg 12- hourly 1st postoperative day: remove bladder catheter in the morning 2nd postoperative day: remove epidural catheter in the morning; discharge after lunch

days were excluded because the research team was not available. Principles of the perioperative care program are shown in Table 1.

For 30 days after surgery we studied the primary hospital stay and readmission rate, time to first defecation, use of intravenous fluid during the surgical procedure, and use of epidural analgesia, nasogastric tube, and urinary bladder catheter. Morbidity and complications requiring treatment were recorded during the first 30 postoperative days. Nonsurgical complications were defined as follows: cardiovascular, pulmonary, urinary tract, and other complications. Surgical complications were defined as follows: wound complication, anastomotic leak, and bowel obstruction requiring reoperation.

Data are presented as median (range). Comparisons were done with the Mann-Whitney test for continuous data and the chi-squared test for categorical data. $P \leq 0.05$ was considered statistically significant.

RESULTS

Median age was 74 (range, 39–90) years in group 1 and 72 (range, 33–94) years in group 2. The preoperative American Society of Anesthesiologists (ASA) score was significantly higher in group 2 ($P < 0.05$); otherwise there were no differences between groups (Table 2).

Median hospital stay was 8 days (range, 3–69 days; mean 10.0 days) in group 1 and 2 days (range, 1–62

Table 2.
Demographics, ASA Score, Preoperative Complicating Diseases, and Type of Surgery in Patients Undergoing Colonic Resection with Conventional Care or Multimodal Rehabilitation

	Group 1	Group 2
	n = 130	n = 130
Age	74 (37–92)	72 (33–94)
Gender M/F	54/76	55/75
ASA[a]		
I	39	25
II	61	53
III	27	42
IV	3	10
Complicating diseases		
Cardiovascular disease	53	55
Chronic pulmonary disease	17	21
Neurologic disease	13	23
Endocrine	13	30
Psychiatric	4	14
Other diseases (*e.g.,* rheumatism, eye diseases, earlier malignancy, and alcohol abuse)	42	39
Impaired mobility	9	40
Patients without complicating diseases and normal mobility	38	25
Underlying disease		
Cancer	106	93
Diverticulitis	15	26
Recurrent volvulus	3	2
Other disease (lymphoma, adenoma, polyps)	7	9
Type of surgery		
Right hemicolectomy	61	50
Resection of transverse colon	8	4
Left-sided hemicolectomy	10	7
Sigmoid resection	49	68
Rectosigmoid resection	1	1

ASA = American Society of Anesthesiologists.
[a] $P < 0.05$ Mann-Whitney test.

days; mean 3.3 days) ($P < 0.05$) in group 2. Defecation occurred median day 4.5 (range, 1–10 days; mean 4.6 days) in group 1 and on day 2 (range, 1–5 days; mean 1.6 days) ($P < 0.05$) in group 2. Time of surgery was median 124 (range, 55–312) minutes in group 1 and 135 (range, 70-360) minutes in group 2 ($P < 0.05$). Intraoperatively, the patients in group 1 received median 2,000 ml saline (range, 800–3,500 ml) and 500 ml plasma expander (range, 0-1,250 ml), whereas the patients in group 2 received median 1,500 ml saline (range, 700–4,200 ml) ($P < 0.05$) and 500 ml plasma expander (range, 0–1,200 ml) ($P > 0.05$). From 24 hours postoperatively, 102 patients in group 1 and 11 patients in group 2 were treated with intraveneous fluid ($P < 0.05$).

In the 115 patients receiving epidural analgesia in group 1, the epidural catheter was removed on median day 3 (0–10 days) and on day 2 (0–2 days) in group 2 ($P < 0.05$). In group 2, an epidural catheter could not be inserted in two patients. The bladder catheter was removed on median day 3 (1–17 days) in group 1 and on day 1 in all patients in group 2 ($P < 0.05$). Urinary retention occurred in 25 patients (19 percent) in group 1 and 14 (11 percent) patients in group 2 ($P < 0.05$). In group 1, 14 patients were treated with "in-and-out" catheterization (4 patients once and 10 patients 2-4 times) compared with 14 patients in group 2 (11 patients once and 3 two times) ($P > 0.05$). Fourteen patients in group 1 were treated with a urinary bladder catheter for median 3 days (range 1–23 days), whereas only one patient in group 2 had a maintained urinary catheter (7 days) ($P < 0.05$).

Twenty-one patients in group 1 had a nasogastric tube postoperatively for median 1 day (range, 1–19 days; mean 3 days). In contrast, only one patient receiving an additional gastrojejunal anastomosis in group 2 had a nasogastric tube (4 days) after the surgical procedure. Twenty patients in group 1 had a nasogastric tube inserted *after* the day of surgery and maintained for median 2 days (range, 1–9 days mean 2.4 days), whereas only two patients in group 2 had a tube inserted for nausea and vomiting in the postoperative period ($P < 0.05$).

In group 1, 16 patients (12 percent) were readmitted for median 7 days (range 1–165 days; mean 17.5 days) and in group 2, 27 patients (20 percent) were readmitted for median 7 days (range, 1–99 days; mean 10.4 days) ($P > 0.05$). In group 1, 8 patients were readmitted for wound infection (1, 1, 2, 5, 6, 7, 9, and 16 days), 2 patients for constipation (1 and 4 days), 1 patient for dehydration (1 day), 1 patient for deep vein thrombosis (16 days), 1 patient for dysphagia (18 days), 1 patient for pulmonary abscess (18 days), 1 patient for further diagnosis of the cancer (11 days), and 1 patient for intra-abdominal abscess (165 days). In group 2, 3 patients were readmitted or observed for wound infection (1, 7, and 12 days), 1 patient for wound rupture (1 day), 1 patient for suture after wound infection (1 day), 4 patients for anastomotic leak (12, 16, 16, and 22 days), 1 patient for bowel obstruction (13 days), 2 patients for constipation (1 and 4 days), 3 patient for vomiting (2, 5, and 8 days), 2 patients for urinary tract infection including epididymitis (1 and 10 days), 6 patients for social reasons (3, 4, 4, 5, 7, and 12 days), 1 patient for psychiatric disease (99 days), 1 patient for spinal headache (7 days), 1 patient for arrhythmia (8 days), and 1 patient was observed for pulmonary disease (1 day). None of the patients in group 1 were readmitted before the eighth postoperative day, whereas 12 patients in group 2 were readmitted before the eighth postoperative day (9 patients were readmitted within 5 days after surgery). The anastomotic leaks were diagnosed on day 3, 4, 8, 8, and 16 in group 1 and on day 2, 4, 5, 7, and 16 in group 2 (fast-track). Total hospital stay (primary postoperative hospital stay plus days of readmission) for group 1 was median 10 days (range, 3–165; mean 13 days), and that for group 2 was 2 days (range, 1–99; mean 5.5 days) ($P < 0.05$).

Within the first 30 postoperative days, 61 group 1 patients (45 percent) and 33 group 2 patients (25 percent) ($P < 0.05$) had one or more complications (Table 3). The total number of medical complications was 69 in group 1 (67 percent of the total number of complications) and 20 in group 2 (48 percent of the total numbers of complications) ($P < 0.05$). Cardiopulmonary complications were significantly lower in group 2 (5 *vs.* 48 complications, $P < 0.01$). Also, the overall surgical complication rate was significantly higher in the conventional care patients: 35 complications in group 1 *vs.* 21 complications in group 2 ($P < 0.05$). Wound complications were significantly higher in group 1 than in group 2, but there was no difference between the incidence of bowel obstruction and anastomotic leak (Table 3). Mortality was four patients in group 1 (1 patient reoperated for an anastomotic leak developed postoperative pulmonary edema and heart failure and died on day 10; 1 patient

Table 3.
Number of Patients With Complications and Total Number of Complications Within the First Postoperative Month After Colonic Resection With Conventional Care (Group 1) and Multimodal Rehabilitation (Group 2)[a]

	Group 1	Group 2
Postoperative complications		
Total number of patients with complications[b]	72	33
Total number of complications[c]	106	41
Total number of patients with medical complications	62	12
Total number of patients with surgical complications	30	19
Medical complications		
Cardiovascular[c]	17	4
Myocardial infarction	3	0
Cardiovascular failure	1	1
Arrhythmia	9	1
Ischemia	3	1
Hypo/hypertension	5	1
Pulmonary[c]	21	1
Pneumonia	13	0
Abscess	1	0
Asthma	4	0
Edema	7	1
Atelectasis	2	0
Thromboembolic	3	2
Cerebral	0	1
Deep venous thrombosis	2	0
Occlusion of shunt	1	0
Ischemic ileum	1	1
Urinary tract	9	6
Infection	7	5
Urosepsis	0	1
Pyelonephritis	1	0
Epididymitis	1	1
Renal failure	1	0
Other complications	8	6
Endocrinologic	3	1
Spinal headache	0	1
Psychiatric	3	1
Hematemesis	3	1
Multiorgan failure	0	2
Mortality	4	6
Surgical complications		
Wound[c]	25	13
Infection	19	9
Rupture	6	2
Bleeding	2	2
Intra-abdominal abscess	2	1
Anastomotic leak	5	5
Bowel obstruction	1	2

[a]Both the number and the type of medical and surgical complications are listed.
[b]$P < 0.05$ chi-squared test between groups.
[c]$P < 0.05$ Mann-Whitney test.

had an anastomotic leak, peritonitis, and multiorgan failure and died on day 17; 1 patient had anastomotic leak and cardiovascular failure and died on day 5l and 1 patient developed pulmonary edema and died on day 19). Six patients in group 2 died (1 patient had wound rupture on day 2 and developed multiorgan failure after reoperation and died on day 9; 2 patients with multiple preoperative strokes had a new stroke: one of them died on day 13, and the other died on day 29 in a nursing care home; 1 patient had cardiovascular failure and died on day 2; 1 patient had pulmonary edema and died on day 1; and 1 patient underwent reoperation for mechanical bowel obstruction and developed multiorgan failure and died on day 11) ($P > 0.05$).

DISCUSSION

Recent efforts to achieve standard perioperative care protocols[5,6,10] for patients undergoing colonic surgery have reduced the postoperative hospital stay to 2 to 3 days, compared with the usual 6 to 10 days.[7,8] Revision of the postoperative care program has occurred in response to recent scientific data demonstrating that routine use of nasogastric tubes is not indicated, that urinary bladder catheterization should be short (1–2 days), and that early oral feeding may be instituted without risk.[5,6]

In recent years several reports have been published from single institutions revising specific parts or the whole perioperative program, confirming that hospital stay can be reduced after colonic surgery[11–14] and also in more complex colorectal procedures.[15]

One of the limiting factors for early recovery after colonic resection has been postoperative ileus. Recent studies have shown, however, that it can be significantly reduced by the use of epidural analgesia with local anesthetics.[16] Although, the ileus-reducing effect of epidural local anesthetic has been confirmed in several randomized trials,[16] the relative role of epidural analgesia *vs.* early oral nutrition and mobilization has not been evaluated.[15] Nevertheless, a significant reduction in hospital stay in colorectal surgery has been achieved by eliminating the routine use of nasogastric tubes and instituting early nutrition without epidural analgesia.[12–15] In the present study both groups had epidural analgesia, and although a more optimal, higher level was employed in group 2 (Table 1) to reduce ileus, group 1 received three days of epidural treatment. This experience shows that single-modality treatment with epidural analgesia may not *per se* lead to significantly earlier recovery of gastrointestinal function, unless it is combined with avoidance of routine use of gastric tubes, and early institution of oral nutrition.

The present consecutive patient series from two university departments of surgical gastroenterology in Denmark demonstrates that fast-track rehabilitation with continuous epidural analgesia and enforced early oral nutrition and mobilization leads to a reduction in hospital stay. It should also be mentioned that patients were given preadmission information about the perioperative care program, and this might also have affected the outcome. More interesting, there was a reduced rate of medical complications, especially, the incidence of cardiopulmonary complications (Table 3). These results were achieved despite that patients with fast-track multimodal rehabilitation had higher ASA scores and a tendency toward more left-sided resections. Also, pulmonary physiotherapy was not used routinely in group 2, whereas it wasused routinely in group 1. It can be argued that the overall morbidity was rather high compared to other reports from single institutions,[11–15] but it should be borne in mind that patients in the present study were generally older and had a high incidence of *preoperative* concomitant diseases than patients in other reported series; in addition, it represents an unselected group of patients, which may makedirect comparisons to other reports difficult.

The physiologic background for the reduced morbidity and hospital stay with fast-track multimodal rehabilitation is well established. This treatment concept leads to preserved body organ functions rather than the usual postoperative deterioration in pulmonary function, body composition, and cardiovascular response to exercise.[9] Also, the fast-track program involves reduced administration of intraoperative fluid and early completion of postoperative intraveneous fluid administration. The resulting avoidance of fluid excess may have contributed to reduced morbidity, because postoperative fluid excess may contribute to cardiopulmonary morbidity[17] and ileus.[18]

It may be argued that fast-track colonic surgery could lead to a higher readmission rate (20 percent in the present study), but more than 65 percent of these readmissions occurred after postoperative day five and therefore might not have been prevented by a longer hospital stay. Also, other studies have indicated that readmissions after colorectal surgery cannot be predicted.[19] In the present study no readmis-

sions were connected with acute life-threatening conditions, even in the cases with anastomotic dehiscence. Also, the incidence of anastomotic dehiscence was similar (3.8 percent) in the two regimens presented in this study, and there were no differences in time of diagnosis. Although the fast-track care confers significant benefit in terms of gastrointestinal functional recovery, postoperative hospitalization, and morbidity, it may be difficult to explain the relative role of the many differences in perioperative care. Those benefits are based primarily on evidence from randomized studies.[5,6] Thus, avoidance of routine use of nasogastric tubes combined with institution of early oral feeding may be the most important factors, but also the use of less fluid may contribute to reduced ileus and cardiopulmonary morbidity.[17,18] The relative role of treatment with laxative (magnesia) and cisapride is difficult to assess, because no randomized study exists on potential benefits of magnesia, and a small prokinetic effect has been demonstrated with cisapride.[16] However, this drug has now been removed from the market because of potential cardiac morbidity. The use of horizontal or curved incisions in the fast-track patients may also have contributed to faster recovery, because they lead to less pain and pulmonary dysfunction than vertical incisions.[6] As discussed above, the use of continuous epidural analgesia provides effective dynamic pain relief, but its role relative to the other factors in improved recovery remains to be demonstrated. However, although both groups in our study received postoperative epidural analgesia, only group 2 patientshad the advantage of the physiologic pain relieving and ileus-reducing effects of enforced mobilization and early oral nutrition, which were part of their postoperative care plan. Thus, most of the care principles in group 2 were founded on scientific evidence and should be included in routine care after colonic surgery. The relative role of epidural analgesia and laxatives, however, should be studied in future trials.

The present results are also interesting within the context of the discussion about laparoscopic-assisted *vs.* open resection in colonic surgery, where the advantages on early recovery so far have been rather limited.[20] However, in existing randomized studies, blinding for the surgical procedure has not been performed, and bias may have influenced the results from changes in postoperative care programs that allowed earlier mobilization and feeding and less restrictive use of nasogastric tubes. Therefore, the effect of laparoscopic surgery for colorectal procedures needs to be reassessed with an optimal study design that compares similar treatment protocols, blinded for the surgical procedure, and with a fast-track multimodal postoperative care program.[21] Preliminary observations with such changes in postoperative care with laparoscopic colonic resection have shown a very short hospital stay (around two days) and very low rates of morbidity and readmission.[13,22–24] Future studies are needed to assess the potential for laparoscopic-assisted surgery to enhance recovery in colorectal procedures. Furthermore, a reassessment of the need for epidural analgesia with the open procedure, as well as with the minimally invasive surgical approach, is warranted.

In conclusion, institution of a multimodal fast-track rehabilitation program reduced hospital stay and medical complications in a comparative, nonrandomized study in elderly high-risk patients undergoing colonic surgery. Further studies are needed to assess the potential for further reduction of morbidity and readmissions with fast-track rehabilitation after colonic surgery.

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Invited Commentary

To the Editor—The authors are to be commended for providing further data to help define the key components for expedited care of the colectomy patient. The key outcome measures are shortened length of stay coupled with reduced morbidity and mortality. The authors have clearly shown that the accelerated rehabilitation program employed at their institution can provide these outcomes, particularly in terms of reducing cardiopulmonary complications. This comparison of two institutions allows an assessment of the relative benefits of various components of the accelerated care plan *vs*. less intensive recovery plans.

Epidural analgesia, although an important component of pain management, does not independently reduce the length of stay or reduce complication rates as both institutions used similar thoracic epidural regimens. Conversely, an aggressive program of ambulation early and daily appears to yield significant benefits for recovery of bowel function and reduction of cardiopulmonary complications. The use of a nasogastric tube enforces a period of artificial ileus, which precludes dietary intake and clearly does not benefit the length of stay or complication rates. The early introduction of dietary intake does stimulate the gastrointestinal tract and likely reduces the time to restoration of bowel function while maintaining nutritional balance. The main limitation of early feeding is ileus related to narcotic effects or surgical stress in certain patients. The only untested component of the care plan used by this research group is the oral cathartic. It certainly induces a bowel movement, however it remains debatable whether the best measure of ileus resolution is a bowel movement or simply the ability to tolerate a sustainable volume of oral intake to support the patient and allow discharge from hospital. Finally, low rates of intra-abdominal and anastomotic complications are essential to rapid recovery and short hospital stays.

Early readmission is a concern when attempting to reduce the length of stay for any medical problem; however, the authors demonstrate that this rate can be maintained at an acceptably low level and, importantly, does not adversely affect overall patient outcome for colectomy.

Basse *et al*. continue to challenge the surgical community in this important area of improved physiologic care of the colectomy patient. The benefits of lower complication rates and hospital stay have significant implications for the individual patient and the health care system at large.

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[Editor's Note—The authors decline to respond to the commentary.]