General Anesthesia

Laparoscopy for colectomy accelerates restoration of bowel function when using patient controlled analgesia

[La laparoscopie pour colectomie accélère la restauration de la fonction intestinale quand on utilise l'analgésie autocontrôlée]

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Purpose: A standardized care plan incorporating patient-controlled analgesia with iv morphine and a non-accelerated feeding schedule following colectomy was used to compare return of bowel function and hospital discharge times following surgery done by laparoscopy or laparotomy.

Methods: Thirty-eight patients were assigned to undergo either laparoscopic or laparotomy colon resection. Postoperative analgesia was achieved with patient-controlled analgesia with iv morphine. General anesthesia and perioperative care were standardized, and a traditional surgical and nursing care program was implemented. Gastrointestinal function (time from surgery to return of passage of flatus and presence of bowel movements), pain intensity (visual analogue scale) at rest, on coughing and on mobilization, amount of morphine used, and criteria for discharge and length of hospital stay were recorded.

Results: Bowel movements resumed earlier in the laparoscopic group ($P < 0.05$), but not passage of flatus. No significant relationship was found between the amount of morphine used and return of bowel function. Cumulative morphine consumption during the first two postoperative days was similar in both groups. Where a trend towards lower postoperative visual analogue scale scores was observed in the laparoscopic group, visual analogue scale scores on coughing were lower in the laparoscopic vs laparotomy group only during the first 24 hr ($P < 0.05$). Length of hospital stay was significantly shorter in the laparoscopic group ($P < 0.05$), although times to meet discharge criteria were similar in both groups.

Conclusions: When patient-controlled analgesia with morphine and a traditional perioperative program are used, a

laparoscopic approach to colon surgery promotes earlier restoration of bowel function and more rapid hospital discharge in comparison to resection by laparotomy.

Objectif : Un plan de soins normalisé comportant l'analgésie auto-contrôlée avec de la morphine iv et un programme d'alimentation postopératoire non accéléré ont été utilisés pour comparer le retour de la fonction intestinale et le temps d'hospitalisation après une opération par laparoscopie ou laparotomie.

Méthode : Trente-huit patients ont subi la résection du colon par laparoscopie ou laparotomie. L'analgésie postopératoire a été réalisée avec la morphine iv autocontrôlée. L'anesthésie générale et les soins périopératoires ont été normalisés et un programme traditionnel de soins chirurgicaux et infirmiers a été implémenté. La fonction gastro-intestinale (le temps écoulé entre l'opération et le passage de gaz intestinaux et de selles), l'intensité de la douleur (à l'échelle visuelle analogique EVA) au repos, pendant la toux et le mouvement, la quantité de morphine utilisée et la réponse aux critères permettant de quitter l'hôpital ainsi que le temps d'hospitalisation ont été notés.

Résultats : Les selles sont revenues plus tôt, mais non les gaz intestinaux, chez les patients opérés sous laparoscopie ($P < 0,05$). Aucune relation significative n'a été trouvée entre la quantité de morphine utilisée et le retour de la fonction intestinale. La consommation cumulative de morphine pendant les deux premiers jours postopératoires a été similaire dans les deux groupes. Avec la laparoscopie, les scores postopératoires à l'EVA tendaient à être plus bas et ils étaient plus bas lors de la toux mais seulement

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pendant les 24 premières heures ($P < 0,05$). Le séjour hospitalier a été significativement plus court avec la laparoscopie ($P < 0,05$) même si les patients des deux groupes ont répondu aux critères de sortie en des temps similaires.

Conclusion : L'utilisation d'une analgésie autocontrôlée avec de la morphine et d'un programme périopératoire traditionnel combinée à une approche laparoscopique de la colectomie, comparée à la laparotomie, favorise la restauration hâtive de la fonction intestinale et le départ précoce de l'hôpital.

MAJOR abdominal surgery is associated with undesirable postoperative events, including ileus, delayed resumption of dietary intake, and longer hospital stay.¹ The main pathogenic factor of ileus is activation of inhibitory splanchnic reflexes as a result of the surgical insult causing pain and inflammation. Attempts have been made to modify this unwanted response by minimizing the surgical stress response, and optimizing postoperative analgesia.

Early studies using a minimally invasive approach to colon resection have shown that laparoscopy reduces the inflammatory response and the incidence of postoperative wound infection, thus facilitating the recovery process.²⁻⁴ This technique has gained popularity following publication of large randomized studies which compared the safety and efficacy of laparoscopic-assisted resection of colorectal malignancy with colectomy done by a laparotomy.⁵⁻⁷ Although many studies comparing these two surgical approaches to colectomy have reported beneficial effects of laparoscopy on restoration of bowel function, few studies have standardized the postoperative analgesia regimen, and perioperative surgical and nursing care.

Epidural administration of local anesthetics reduces the duration of postoperative ileus^{8,9} and continuous epidural analgesia with combined local anesthetics and opioids provides the most effective analgesic strategy after colon surgery.¹⁰ A recent study comparing the use of thoracic epidural anesthesia and analgesia with morphine patient-controlled analgesia (PCA) for pain relief after laparoscopic colectomy demonstrated superior analgesia associated with the epidural, and no difference in hospital length of stay or postoperative morbidity.¹¹ The authors of this investigation suggested that the laparoscopic approach, and not the type of analgesia, was the main determinant of recovery.¹¹ However, while epidural analgesia provides some advantages over

systemic opioid analgesia, the benefit of the former technique for minimally invasive surgery has been questioned.¹²

Over the past decade, several accelerated perioperative care programs which combine preoperative education and optimization of patients' health status, intraoperative attenuation of surgical stress, postoperative multimodal analgesia, enforced mobilization and early oral nutrition, together with revision of traditional practice of surgical care, have been applied successfully for different types of surgery with the intention to minimize the incidence of postoperative morbid events, and accelerate the recovery process.¹³ This implies that the organization of perioperative care could very well influence surgical outcome, while the type of surgical approach and nature of postoperative analgesia might not be relevant factors *per se* in determining the extent of postoperative recovery.

With this background knowledge, we undertook the current investigation to compare the effect of two surgical approaches, laparotomy *vs* laparoscopic colon resection, to evaluate their impact on restoration of bowel function when patients receive *in* PCA morphine. A traditional, non-accelerated, perioperative care program was implemented, while ensuring similarity of groups with respect to standardization of perioperative surgical, anesthetic and nursing care.

Methods

Following a recently published randomized trial comparing the effect of epidural analgesia with PCA on postoperative functional recovery in subjects undergoing colonic surgery,¹⁴ we extended the outcome study to a larger non-randomized population where the surgical approach included either laparoscopy or laparotomy, and postoperative analgesia was achieved with either epidural or PCA. This project was approved by the Institutional Ethics Board. From this large group, 38 consecutive patients scheduled to undergo either laparotomy or laparoscopy for elective colon resection were selected if they were scheduled to receive postoperative analgesia with PCA morphine. The decision to perform either a laparotomy or a laparoscopy was made by the surgical team based upon the location and size of the lesion, ease of surgical access, patient's physical characteristics and medical conditions, and patient preference.

All patients were approached two weeks before surgery, and the protocol was explained in detail. Patients with severe cardiopulmonary disease (ASA physical status IV), sepsis, inflammatory bowel disease, chemotherapy or radiotherapy within the six months preceding surgery, and those with an inability

to communicate or understand the aim of the project, were excluded. Subjects were not blinded, and were enrolled on the basis that both surgical approaches were equally acceptable to them.

Anesthesia and analgesia

Patients were not premedicated. General anesthesia consisted of propofol, fentanyl, rocuronium, and up to 6% end-tidal desflurane in a mixture of air and 40% oxygen. Supplemental boluses of fentanyl 50 µg *iv* were administered during surgery, as needed. Pain relief in the immediate recovery period was achieved with fentanyl 25–50 µg *iv* to maintain a visual analogue scale (VAS 0–10, where 0 is no pain and 10 unbearable pain) at rest, less than 3. Intravenous PCA morphine was initiated and continued for up to 72 hr after surgery. The PCA regimen consisted of morphine at 1–2 mg *iv*, with a five-minute lockout interval, and a maximum hourly dose of 15–20 mg. The maximum dose was increased if the VAS at rest was greater than 3, or on coughing greater than 5. The PCA medication was discontinued on postoperative day (POD) three unless the VAS score at rest was greater than 3. Patients in both groups also received naproxen 500 mg *po* bid and acetaminophen 1 g *po* qid, starting in the recovery room and continuing for the first four PODs. Thereafter, oral codeine up to 60 mg *po* every six hours and acetaminophen 1g *po* qid were prescribed until discharge. Supplemental oxygen (30% oxygen via Hudson mask) was provided to all patients during the first 24 postoperative hours.

Surgical procedures

All patients were operated upon by two colorectal surgeons, fellowship-trained in both laparoscopic and laparotomy colorectal surgery. For the laparoscopic technique pneumoperitoneum was achieved using a 12-mm blunt-tipped Hasson cannula inserted under direct vision into the peritoneal cavity through a small vertical infra-umbilical incision, and was maintained with CO₂ adjusted to a pressure of 12 mmHg. The initial incision was later enlarged to 4–5 cm, to facilitate delivery of the colon for resection and re-anastomosis. Three additional 5-mm trocars were placed under laparoscopic vision. For right hemicolectomies, the colon was mobilized laparoscopically. The mesentery was divided after delivering the colon into the wound. The resection and anastomosis were performed extracorporeally. For left colon resections, the colon was mobilized laparoscopically, and blood vessels were divided intracorporeally. The colon was then divided intracorporeally and delivered through a small incision. The anastomosis was completed

intracorporeally using the double-stapled end-to-end anastomotic circular stapling technique. For the laparotomy technique, a lower midline incision was used to perform the resection. Drainage was not used.

Traditional, non-accelerated, perioperative care

All patients attended the preoperative clinic where they were instructed about standard intraoperative and postoperative care for their surgery. Patients were told to expect to stay between five and ten days in hospital. Routine mechanical bowel preparation consisted of a clear liquid diet and polyethylene glycol 4 L administered the day before surgery. Patients were admitted to hospital on the morning of surgery.

Antibiotic prophylaxis was provided with metronidazole 500 mg *iv* and cefazolin 2 g *iv*, 20 min prior to skin incision. Nasogastric tubes and abdominal drains were not used. During surgery all patients received an *iv* infusion of 0.9% normal saline at a rate of 6 mL·kg⁻¹·hr⁻¹. No blood was transfused unless blood loss was greater than 20% of patient's estimated circulating volume. A thermal blanket set at 40°C was positioned on the exposed parts of the body to maintain normothermia.

An *iv* infusion of dextrose/saline was started after surgery, and continued for a minimum of 48 hr. Patients were allowed only sips of water during the first 24 postoperative hours, followed by full liquid diet composed of nutritional supplement in liquid form, containing up to 60 g of proteins and 1200 calories/day. The oral supplement was changed subsequently to either a semi-solid or solid form if tolerated by the patient, and dependent upon presence of rectal passage of flatus. Nausea and vomiting were controlled with antiemetic medications, and temporary discontinuation of the liquid diet. In case of a distended abdomen and protracted vomiting and ileus, the diet was discontinued completely, *iv* fluids were provided, and a nasogastric tube was inserted.

Patients in both groups were encouraged, but not forced, by the ward assistant to mobilize on the first POD by sitting in a chair, progressing to assisted ambulation. Time out of bed, either sitting or waking, was recorded by the patients in their own journal. The surgical team visited all patients daily, and recorded clinical progress and complications, as a well bowel function (passage of flatus, presence of bowel movements). A dedicated research nurse recorded demographic data, VAS pain scores, food intake, mobility, and hospital length of stay. The research nurse also determined readiness for hospital discharge according to standard criteria (patients fully mobile without assistance, tolerance of semi-solid and solid food

TABLE I Demographic and clinical data

	<i>Laparotomy</i> (<i>n</i> = 18)	<i>Laparoscopy</i> (<i>n</i> = 19)
Age (yr)	64 ± 10	61 ± 15
Gender (M/F)	10/8	11/8
BMI (kg·m ²)	25 ± 3	26 ± 5
Body weight (kg)	71 ± 12	78 ± 17
ASA status (I/II/III):	2/14/2	3/15/1
<i>Diagnosis</i>		
Cancer	12	10
Diverticulitis	3	4
Polyps	0	3
Adenoma	3	2
<i>Type of surgery</i>		
Right hemicolectomy	7	8
Left hemicolectomy	3	0
Sigmoid colectomy	6	8
Anterior resection	2	3
Duration of surgery	193 ± 51	212 ± 63
Blood loss (mL)	355 (120–670)	220 (110–485)

M = male; F = female; BMI = body mass index. Values are expressed as mean ± standard deviation or median (95% confidence interval).

without nausea and vomiting, absence of infection and pain, and passage of stool).

Outcome measurements

The primary outcome was return of bowel function (time from surgery to passage of flatus, and bowel movements). Secondary outcomes included: quality of postoperative analgesia as assessed by VAS pain scores at rest, on ambulation, and on coughing, consumption of daily PCA morphine for the first two POD, fatigue VAS (0–10; where 0 represents no tiredness, and 10 greatest tiredness), gastrointestinal function (nausea and vomiting requiring treatment, and intake of full fluids and full diet), and time out of bed (either sitting or walking), and time of hospital discharge (readiness to discharge and hospital length of stay).

Sample size and statistical analysis

The sample size was based upon a previously published study from our own institution,⁹ and with an α level of 0.05 and a power of 80%, a minimum of 18 patients per group would be needed to detect a 12-hr difference in the recovery of bowel movements between the two groups. Data are presented as mean ($\pm$ standard deviation) or median (95% confidence interval) when data were not normally distributed, and were compared between groups using either a two-tailed Student's *t* test or the Mann-Whitney *U* test. The

TABLE II Postoperative recovery of gastrointestinal function

	<i>Laparotomy</i> <i>n</i> = 18	<i>Laparoscopy</i> <i>n</i> = 19	<i>P</i> value
Passage of flatus (days)	3.7 ± 2.9	2.4 ± 1.2	0.10
Time to first bowel movements (days)	5.6 ± 3.9	3.8 ± 2.5	0.02
<i>Passage of flatus (n, %)</i>			
0–24 hr	0 (0%)	2 (11%)	0.49
0–48 hr	5 (28%)	8 (42%)	0.50
0–72 hr	10 (55%)	14 (78%)	0.31
0–96 hr	14 (78%)	17 (89%)	0.41
<i>Bowel movements (n, %)</i>			
0–24 hr	0 (0%)	1 (5%)	1.00
0–48 hr	1 (5%)	9 (47%)	< 0.01
0–72 hr	4 (22%)	9 (47%)	0.170
0–96 hr	7 (39%)	16 (84%)	< 0.01

Chi-square test was used for proportions. For rank correlation analysis Spearman's ρ was used. A *P* value < 0.05 was considered statistically significant. Statistical analysis was performed with Intercooled Stata 8.0 statistical package (Stata, TX, USA).

Results

One patient in the laparotomy group was excluded from the analysis as he was found at surgery to have disseminated peritoneal carcinomatosis. All remaining patients completed the study protocol. The demographic characteristics and the clinical data of the two groups were similar (Table I).

With respect to recovery of bowel function, time to first passage of flatus tended to resume earlier in the laparoscopic group compared with the laparotomy group, whereas bowel movements resumed on average 1.8 days earlier in the laparoscopy group *vs* the laparotomy group (*P* < 0.05, Table II).

Data on postoperative VAS scores, morphine PCA consumption and hospital stay are presented in Table III. Although there was a trend towards lower VAS pain scores in the laparoscopy group, VAS scores at rest and on ambulation were similar in the two groups, with the exception of lower VAS scores on coughing during the first POD in the laparoscopy group (*P* < 0.05 *vs* laparotomy group). Cumulative morphine consumption was similar in the two groups during the first two POD. No significant correlation was found between the amount of morphine used during the first 48 hr and the time to first bowel movement (ρ = 0.23, *P* = 0.12). Length of hospital stay was shorter

TABLE III Visual analogue scale pain scores, postoperative morphine patient controlled analgesia consumption, and discharge data

	Laparotomy <i>n</i> = 18	Laparoscopy <i>n</i> = 19	<i>P</i> value
<i>VAS at rest (cm)</i>			
Day 1	4.1 ± 3.6	2.5 ± 2.8	0.12
Day 2	3.4 ± 2.5	2.5 ± 3.1	0.37
Day 3	2.1 ± 2.0	2.1 ± 2.8	0.99
Day 4	1.7 ± 1.9	2.1 ± 2.5	0.63
<i>VAS on ambulation (cm)</i>			
Day 1	6.7 ± 2.9	3.5 ± 3.3	0.06
Day 2	4.9 ± 2.8	3.4 ± 2.9	0.16
Day 3	4.1 ± 2.6	3.4 ± 3.5	0.52
Day 4	2.9 ± 2.6	3.8 ± 3.0	0.47
<i>VAS on coughing (cm)</i>			
Day 1	7.2 ± 2.6	4.1 ± 3.2	0.005
Day 2	5.8 ± 2.5	4.5 ± 4.1	0.28
Day 3	4.1 ± 2.9	4.2 ± 3.2	0.99
Day 4	4.1 ± 3.0	4.9 ± 3.0	0.52
<i>Morphine PCA (mg)</i>			
Day 1	24.7 ± 20.9	29.6 ± 20.1	0.72
Day 2	18.4 ± 23.3	17.3 ± 25.6	0.63
Total 48 hr	43.72 ± 40.10	47.88 ± 37.55	0.15
Hospital stay (days)	8.4 (4.9–10.6)	4.2 (3.5–5.7)	0.03
Readiness for discharge (days)	5.6 (4.1–7.9)	3.9 (3.1–5.6)	0.23

VAS = visual analogue scale (0–10 cm); PCA = patient controlled analgesia.

TABLE IV Postoperative fatigue and activity data

	Laparotomy <i>n</i> = 18	Laparoscopy <i>n</i> = 19	<i>P</i> value
<i>Fatigue VAS (cm)</i>			
Day 1	7.3 ± 3.0	5.5 ± 3.3	0.13
Day 2	7.3 ± 3.2	6.3 ± 3.1	0.36
Day 3	5.6 ± 3.2	5.5 ± 3.8	0.97
Day 4	6.3 ± 3.5	5.5 ± 4.1	0.61
<i>Mobilization out of bed (min)</i>			
Day 1	59 ± 57	112 ± 70	0.03
Day 2	109 ± 61	160 ± 116	0.14
Day 3	204 ± 65	194 ± 144	0.83
Day 4	183 ± 112	185 ± 111	0.97

VAS = visual analogue scale (0–10). Values are expressed as mean ± standard deviation.

in the laparoscopic group, but readiness times for discharge were similar in both groups. Finally, fatigue VAS scores were similar in both groups, and activity out of bed, which included sitting or walking, was significantly greater in the laparoscopic group only on the first POD ($P < 0.05$, Table IV).

Discussion

This study demonstrates that patients undergoing laparoscopic colon surgery resume bowel function more quickly, and leave hospital earlier than patients undergoing colon resection by laparotomy.

A large body of literature attests to the fact that certain aspects of the stress response to intra-abdominal procedures may be attenuated using a laparoscopic approach to surgery. These elements include moderation of inflammatory and metabolic responses, decreased pain, improved pulmonary function, and a decreased rate of wound infection.^{2–4} One might assume that earlier recovery of bowel function and hospital discharge following laparoscopic surgery may be associated with less extensive tissue damage. However, a recent study comparing a conventional with a fast-track accelerated perioperative program in patients undergoing laparoscopic colectomy suggests this not the case.¹⁵ Both groups in this study had epidural analgesia, but only patients in the fast-track accelerated group received early oral feeding enforced mobilization. Patients in the conventional group, who did not receive the multimodal intervention, had bowel movements on the third POD and were discharged from hospital, on average, on the seventh POD.¹⁵ Braga *et al.* reported similar findings in patients undergoing laparoscopic surgery who received epidural analgesia. Patients in their study had a mean time to initiation of bowel movements of 4.8 days, and mean hospital length of stay of 10.4 days.¹⁶ The latter results are similar to our previously-published findings where patients received postoperative epidural analgesia, but underwent colectomy via laparotomy in a conventional perioperative care program.¹⁴

Neither the present study, nor any of the above three trials^{14–16} implemented a “fast-track” accelerated multimodal rehabilitation program. There is good evidence that postoperative outcome is influenced by multiple factors other than the surgical approach and quality of analgesia. Such factors include preoperative patient optimization and education, standardized surgical care, and a well defined and supervised postoperative program.^{17–19} The importance of a multimodal rehabilitation program to outcome is confirmed by a recent blinded, randomized study comparing outcome following laparoscopic colectomy *vs* colon resection by laparotomy, where a multimodal rehabilitation program showed no difference in early postoperative recovery including return of bowel function and hospital stay between the two groups.²⁰

Mean VAS pain scores, both at rest, and on ambulation, were not significantly different between groups during the first four PODs, except for VAS scores

during coughing on POD one. Similarly, the amount of morphine used during the first two PODs was not different between groups. These observations may appear to be in contrast with earlier findings reporting improved analgesia and lower morphine consumption associated with laparoscopic surgery. However, the present study was not *a priori* powered to address this question. The similarity of morphine requirements during the first POD may be explained, in part, by a longer mobilization time in the laparoscopic group. Patients in the laparoscopic group were out of bed on the first day for an average of two hours, as compared with one hour in the laparotomy group. Similarly, on the second day, mobilization time was greater in the laparoscopic group, implying that these patients were significantly more active, even if pain intensity on ambulation was no less than that experienced by patients in the laparotomy group. With the present study design we could not establish whether patients undergoing laparoscopic colectomy had different expectations from patients in the laparotomy group, and different levels of motivation to overcome pain and discomfort. The issue of patient satisfaction with either surgical approach needs to be addressed.

In the present study the criteria for discharge from hospital (full mobility without assistance, tolerance of semi-solid and solid food without nausea and vomiting, absence of infection and pain, and presence of bowel movements) were assessed on a daily basis. Such aggregate criteria have not been applied systematically in other studies, making it difficult to interpret published data based upon duration of hospital stay alone. While time to first flatus is used as an indicator of restored bowel function by some authors,¹¹ we believe that resumption of bowel movements is a well defined and more reliable parameter. It is of interest to observe that although both groups met criteria for discharge at similar times, patients who underwent colectomy by laparotomy left hospital, on average, three days after the criteria for discharge were achieved. There is no obvious explanation for this discrepancy, although it demonstrates that length of hospital stay can be influenced by the health care system, the administrative culture of the hospital, and doctors and patients' expectations. Standardized perioperative care plans have been shown to minimize variations in perioperative care, and may potentially influence hospital length of stay and patient morbidity.^{21,22}

In conclusion, when patients receive PCA morphine for postoperative analgesia, and a traditional surgical and nursing perioperative care program is implemented, a laparoscopic approach to colectomy accelerates return of bowel function and shortens

length of hospital stay in comparison to colectomy performed by laparotomy.

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