Laparoscopic right hemicolectomy with intracorporeal versus extracorporeal anastamosis: a comparison of short-term outcomes

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Background: There is wide variation among laparoscopic colon resection techniques, including the approach for mobilization and the extent of intracorporal vessel ligation, bowel division or anastamosis. We compared the short-term outcomes of laparoscopic right hemicolectomy (LRHC) with intracorporeal (IA) versus extracorporeal (EA) anastamosis.

Methods: We retrospectively reviewed all elective laparoscopic right hemicolectomies performed at St. Joseph's Hospital between January 2008 and September 2009 and compared the demographic, pathologic, operative and outcome data.

Results: Fifty LRHCs were completed during the study period: 21 IA and 29 EA. The groups were similar in age, sex, body mass index, American Society of Anesthesiologists score, previous laparotomy and preoperative invasive pathology. There was no difference between IA and EA in mean duration of surgery (170 v. 181 min, $p = 0.78$), estimated blood loss (14 v. 42 mL, $p = 0.15$), perioperative blood transfusions (5% v. 14%, $p = 0.29$), in-hospital morbidity (33% v. 41%, $p = 0.56$), out-of-hospital morbidity (19% v. 31% $p = 0.34$), emergency department visits (10% v. 17%, $p = 0.16$) or 30-day readmissions (5% v. 7%, $p = 0.75$). There was 1 anastamotic leak in each group and no perioperative deaths. Median length of stay was significantly shorter for IA (4 v. 5 d, $p = 0.05$). There were 6 extraction site hernias with EA and none with IA ($p = 0.026$).

Conclusion: Laparoscopic right hemicolectomy with IA has the advantage of a less hernia-prone Pfannenstiel extraction site, faster recovery and shorter stay in hospital EA.

Contexte : Il existe énormément de variations entre les techniques d'exérèse du côlon par laparascopie, y compris en ce qui concerne l'approche adoptée pour la mobilisation et l'étendue de la ligature vasculaire intracorporelle, la séparation du côlon ou l'anastomose. Nous avons comparé les résultats à court terme de l'hémicolectomie droite laparascopique (HDL) avec anastomose intracorporelle (AI) à ceux de l'HDL avec anastomose extracorporelle (AE).

Méthodes : Nous avons effectué une analyse rétrospective de toutes les hémicolectomies droites laparascopiques non urgentes pratiquées à l'hôpital St. Joseph entre janvier 2008 et septembre 2009, et comparé les données démographiques, pathologiques et opératoires et les données sur les résultats.

Résultats : Cinquante HDL ont été pratiquées au cours de l'étude : 21 avec AI et 29 avec AE. Les groupes de patients étaient comparables pour ce qui était de l'âge, du sexe, de l'indice de masse corporelle, du score de l'American Society of Anesthesiologists, des antécédents de laparatomie et de la pathologie invasive préopératoire. Aucune différence n'a été observée entre l'AI et l'AE pour ce qui est de la durée moyenne de l'intervention chirurgicale (170 c. 181 min, $p = 0{,}78$), de la perte de sang estimée (14 c. 42 mL, $p = 0{,}15$), des transfusions sanguines péri-opératoires (5 % c. 14 %, $p = 0{,}29$), de la morbidité hospitalière (33 % c. à 41 %, $p = 0{,}56$), de la morbidité extra-hospitalière (19 % c. 31 %, $p = 0{,}34$), des admissions à l'urgence (10 % c. 17 %, $p = 0{,}16$) ou des réadmissions à l'hôpital dans les 30 jours (5 % c. 7 %, $p = 0{,}75$). On a signalé 1 fuite anastomique dans chaque groupe, mais aucun décès péri-opératoire. La durée médiane de l'hospitalisation était significativement plus courte pour les AI (4 c. 5 j, $p = 0{,}05$). Il y a eu 6 hernies au point d'extraction pour les AE, mais aucune pour les AI ($p = 0{,}026$).

Conclusion : L'hémicolectomie droite laparascopique avec AI a l'avantage de réduire le risque d'hernie au point d'extraction après incision de Pfannenstiel, d'accélérer le rétablissement de réduire la durée de l'hospitalisation.

Laparoscopic right hemicolectomy (LRHC) has gained acceptance in the treatment of a variety of benign and malignant conditions. Large randomized trials have demonstrated oncologically equivalent outcomes for laparoscopic and open colon resection.[1–3] Laparoscopy has the additional benefits of improved postoperative recovery, reduced analgesia requirements and shorter length of hospital stay.[2,4–6] There is also evolving evidence for long-term benefits, including reduced bowel obstructions and ventral hernias.[4,7–9]

There is wide variation among laparoscopic colon resection techniques, including the approach for mobilization (medial-to-lateral v. lateral-to-medial) and the extent of intracorporeal vessel ligation, bowel division or anastamosis.[1,5] Various terminology has been used to describe the different approaches. The term laparoscopic-assisted colectomy encompasses procedures in which a variable portion of the dissection and mobilization is performed intracorporeally followed by exteriorization of the bowel for the extracorporeal anastamosis (EA).[3,4,10] Alternatively, a totally laparoscopic colectomy refers to a procedure in which the entire mobilization, resection and anastamosis is performed intracorporeally (IA) before specimen extraction.[3,4,10] We sought to compare the short-term outcomes of LRHC using either an IA or EA technique.

Methods

Patients

We retrospectively reviewed the charts of all patients undergoing elective LRHC performed by 5 surgeons at St. Joseph's Hospital, Toronto, Ont., between January 2008 and September 2009. This time frame was a sample of convenience with intermediate follow-up for hernias. Patients were identified from the operating room database by procedure codes. Patients undergoing extended right hemicolectomy or ileocolic resection were included. Patients undergoing emergency procedures or those who had a conversion to open procedure were excluded from the analysis.

We collected patient demographic, preoperative and operative data, including age, sex, body mass index (BMI), American Society of Anesthesiologists (ASA) score, comorbidities, previous laparotomy, preoperative diagnosis, computed tomography (CT) findings, duration of surgery, extraction site, analgesia (epidural or spinal), number of stapler firings, use of alternate devices, estimated blood loss (EBL), intraoperative blood transfusions and complications. We also collected pathologic data, including tumour–node–metastasis (TNM) status, number of nodes examined, number of positive nodes and lymphovascular invasion. Outcome data included length of stay (LOS), in-hospital complications, intensive care unit (ICU) admissions, out-of-hospital complications, emergency department visits and 30-day readmissions. Patients were monitored for extraction and port site hernias with a median follow-up time of 32 months.

Surgical technique

All patients underwent colonoscopy. Patients also had CT imaging of the abdomen unless the indication for colectomy was a polyp not amenable to endoscopic removal, without documented dysplasia or malignancy.

Preoperative prophylaxis with unfractionated heparin and intravenous antibiotics was administered to all patients. Patients did not receive preoperative mechanical bowel preparation, routine nasogastric tubes or drains. The insertion of an epidural or spinal anesthetic was determined by the anesthesiologist.

Intraoperatively, mobilization was performed with the medial-to-lateral approach. Vascular pedicles were ligated with clips or vascular stapler cartridges.

The EA involved a midline extraction or transverse rectus extraction site. The bowel division was performed with open staplers. A side-to-side stapled anastamosis was performed and the enterotomy was closed with a linear stapler. The extraction sites were closed at the fascial level using running absorbable suture (0 Biosyn).

The IA required division of the ileum and transverse colon with endoscopic staplers, followed by a side-to-side endoscopic stapled anastamosis (3 staple cartridges). The enterocolotomy defect was then closed with a running absorbable 3–0 suture (Polysorb). The specimen extraction was usually performed through a traditional Pfannenstiel incision with a transverse incision of the skin, subcutaneous tissue and rectus sheath, followed by vertical spreading of the rectus muscles in the midline. However, 1 patient had a transverse rectus extraction site and 1 had a midline extraction. The Pfannenstiel incision was closed with absorbable interrupted muscular sutures (2–0 Polysorb) and a running fascial stitch (0 Biosyn).

Fascial incision length was not documented in the records for this review. However, in our practice, usual fascial incisions start at 4–5 cm for IA and 7–8 cm for EA. A longer initial incision is required for EA to accommodate the presence of both proximal and distal bowel lumens and staplers in the extraction site. Incisions are extended to accommodate body habitus, specimen size and bulky mesenteries as needed.

Statistical analysis

We performed our satistical analyses using SPSS software version 20.0. Quantitative variables were analyzed using a 2-tailed, unpaired Student t test. Categorical variables were analyzed using the Pearson χ^2 or Fisher exact test. We considered results to be significant at $p < 0.05$.

Results

Demographics

Fifty patients underwent an elective laparoscopic right colon resection during our study period: 29 with EA and 21 with IA. The procedures included 45 right hemicolectomies, 4 extended right hemicolectomies and 1 ileocolic resection. Our sample comprised 26 men and 24 women. There was no difference in demographic and clinical characteristics, including mean age, sex, BMI, previous laparotomy, preoperative invasive pathology and mean ASA score, between the EA and IA groups (Table 1).

Intraoperative data

Most patients undergoing an EA procedure had a midline extraction site (93%). Alternatively, a Pfannenstiel incision was used for most IA procedures (90%).

When comparing EA and IA procedures, there was no difference in mean duration of surgery, mean EBL, stapled ileocolic pedicle or use of a spinal versus an epidural anesthetic. The average number of Endo GIA stapler firings was 0.6 for the EA group and 4 for the IA group. The average number of open GIA and TA staplers for used for laparoscopically assisted procedures was 3 and 1, respectively. No patients required intraoperative blood transfusions (Table 2).

Final pathology revealed invasive adenocarcinoma in more EA than IA patients (24 v. 9, $p = 0.003$). In those patients with invasive cancer, there was no difference between groups in terms of tumour size, number of nodes examined or number of positive nodes. There was no difference in use of postoperative patient-controlled analgesia or postoperative blood transfusion between the EA and IA groups (Table 3).

The median LOS was significantly shorter for the IA than the EA group (4 v. 5 d, $p = 0.05$). The IA group also had an earlier resumption of solid oral intake (2.43 vs. 3.2 d, $p = 0.023$). There was no difference in in-hospital morbidity or mortality, out-of-hospital morbidity, ICU admissions, emergency department visits and 30-day readmissions (Table 4). The most common morbidities were wound infections, ileus and cardiac arrhythmias.

Table 1. Patient demographic and clinical characteristics*

Characteristic	IA	EA	*p* value
No. of patients	21	29	
Age, mean yr	65	69	0.32
Male:female	13:8	13:16	0.23
BMI, mean	27:67	28:64	0.56
Previous laparotomy, yes:no	4:17	4:25	0.71
Preoperative colonoscopy yes:no	21:0	29:0	> 0.99
Preoperative pathology invasive: all others	11:10	16:13	0.85
Preoperative CT yes:no	19:2	26:3	0.92

BMI = body mass index; CT = computed tomography; EA = extracorporeal anastomosis; IA = intracorporeal anastomosis.
*Indications for operation included invasive neoplasm ($n = 27$), dysplastic polyp ($n = 5$), adenoma ($n = 9$), benign lesion ($n = 2$), indeterminate lesion ($n = 4$), appendiceal mass ($n = 1$) and unknown ($n = 2$).

Table 2. Intraoperative data

	Extraction site, no. (%)*		
Intraoperative measure	IA	EA	*p* value
Midline	1	27	0.001
Pfannenstiel	19	0	
Transverse rectus	1	2	
Duration of surgery, mean (range) min	170 (121–237)	181 (98–205)	0.78
IC pedicle (stapled:other)	19:2	17:12	0.013
No. Endo GIA, mean	4.0	0.6	0.001
No. open GIA, mean	0.0	3.0	0.001
No. open TA, mean	0.1	1.0	0.001
Use of alternate devices, yes:no	4:17	4:25	0.62
ASA score, mean	2.65	3.04	0.10
EBL, mean mL	14	43	0.15
No. intraoperative transfusions	0	0	
Anesthesia, epidural:spinal	3:14	7:15	0.55

ASA = American Society of Anesthesiologists; EA = extracorporeal anastomosis; EBL = estimated blood loos; IA = intracorporeal anastomosis; IC = ileocolic.
*Unless otherwise indicated.

With a median follow-up of 32 months, there were significantly more extraction site hernias in the EA group than the IA group (6 v. 0, $p = 0.026$). There was 1 asymptomatic port site hernia in the IA group.

There was 1 reoperation in the IA group for an anastamotic leak. The patient was a 51 year-old man with a preoperative diagnosis of a tubulovillous adenoma with high-grade dysplasia. His postoperative course was complicated by an anastamotic leak requiring a laparotomy and end ileostomy. The patient also experienced a pulmonary embolism and a wound infection, and his total LOS was 28 days.

There was 1 contained anastomotic leak in the EA group requiring percutaneous drainage. The 54-year-old otherwise healthy man had a preoperative diagnosis of tubulovillous adenoma with high-grade dysplasia. The patient's initial LOS was 4 days. A rectus sheath hematoma developed, and he was readmitted with an intra-abdominal abscess requiring percutaneous drainage. The drainage output was confirmed to be a controlled fistula from an anastamotic leak. The fistula was managed on an outpatient basis and resolved with conservative management.

Table 3. Postoperative data

Postoperative measure	IA	EA	*p* value
PCA, yes:no	5:16	14:15	0.08
Postoperative transfusion, yes:no	1:20	4:25	0.29
Type, invasive:all others	9:12	24:5	0.003
Gross size (invasive only) cm	5.44	4.82	0.43
Node positive (invasive only), yes:no	5:4	14:10	0.89
No. positive nodes (invasive only)	2.78	2.54	0.86
No. nodes examined (invasive only)	19.1	17.2	0.50

EA = extracorporeal anastomosis; IA = intracorporeal anastomosis; PCA = patient-controlled analgesia.

Table 4. Outcome data

Outcome measure	IA	EA	*p* value
Median LOS, d	4.00	5.00	0.05
Mean LOS, d	5.33	5.86	0.67
Mean d to resumption of fluids	0.90	1.10	0.14
Mean d to resumption of solids	2.43	3.21	0.023
In-hospital complications, yes:no	7:14	12:17	0.56
Out-of-hospital complications, yes:no	4:17	9:20	0.34
Wound infection, yes:no	3:18	7:22	0.39
Hernia, yes:no			
Extraction site	0:21	6:23	0.026
Total	1:20	6:23	0.11
No. of reoperations required	1	0	
No. of ICU admissions	1	0	
Emergency department visits, yes:no	2:19	5:14	0.16
In-hospital mortality	0	0	
30-d readmission, yes:no	1:20	2:27	0.75

EA = extracorporeal anastomosis; IA = intracorporeal anastomosis; ICU = intensive care unit; LOS = length of stay.

Discussion

Laparoscopic colorectal surgery offers both short and long-term benefits compared with open colorectal surgery. These benefits include less postoperative pain, better pulmonary function, less postoperative ileus and shorter LOS. In addition, meta-analysis and randomized controlled trials with level-1 evidence have demonstrated that laparoscopic colorectal surgery achieves oncological outcomes that are no different from those achieved with the conventional open approach.[11–13]

The results of our study show that LRHC with IA is associated with significantly shorter median LOS and fewer extraction site hernias than EA. The factors affecting LOS are difficult to determine from this retrospective review but are likely numerous. It has been established that lower abdominal incisions in both open and laparoscopic abdominal surgery have numerous advantages, including decreased pain, fewer pulmonary complications and earlier return to gastrointestinal function, compared with mid- or upper abdominal incisions.[14–18] All of these factors are thought to influence LOS. We postulate that these advantages factor into the shorter median LOS in the IA group, who generally had their extractions at the low suprapubic Pfannenstiel site. Our findings are consistent with those reported in case–control studies and a systematic review comparing totally laparoscopic (with IA) and laparoscopically assisted (with EA) right hemicolectomy.[10,12]

Incisional hernia is a complication of both open and laparoscopic colorectal surgery. The initial enthusiasm regarding potential decreases in incisional hernia owing to smaller incisions after laparoscopic colorectal surgery has been somewhat tempered. At least 2 prospective randomized trials have shown similar hernia rates after midline incision in both open and laparoscopic colonic surgery.[19,20] The reported ranges were disparate between the investigations, with 1 trial reporting rates of 4.7% versus 8.9% and the other reporting rates of 24.3% versus 19.6% for laparoscopic versus open surgeries, respectively. The differences in absolute numbers between the 2 trials may be related to definitions used for incisional hernia. It should be noted that the literature is somewhat inconsistent, as these data contradict the results of other reviews.[8,9] The reason for not realizing improved hernia rates after midline extraction sites compared with open laparotomy are not well described. It may relate to abdominal force distribution over a shorter incisional length. This relatively increased force per unit length may obviate the benefit of the smaller incision as it relates to hernia formation.

The benefit of transverse incisions on hernia occurrence for laparotomy and laparoscopic colorectal extractions are well described.[7,17,21–23] Although not proven, the reason that muscle spreading, transverse fascial extraction incisions are less hernia prone is likely based on anatomic principles. First, spreading the rectus, transverse or oblique musculature in

the direction of its fibres spares the blood supply as the incision runs parallel to the segmental arteries supplying them. Second, reapproximation of the muscle affords a type of 2-layer closure in that the muscle may buttress the fascial repair. Third, the defects created in the muscle and fascia lay perpendicular to each other, resulting in no significant full-thickness disruption of the abdominal wall at any given point along the incision when the layers are closed. The midline incision, however, results in a full-thickness injury through the relatively avascular linea alba, which is then susceptible to the lateral forces generated along its length.

Although there are substantial data supporting the association between laparoscopic colorectal resections with transverse extraction sites and less hernia formation, these studies usually examine all colonic segments of resection.[7,22,23] With total colectomy, left-sided and rectal resections, the IA may be performed with a circular stapling device transanally to create an ileo- or colorectal anastomosis. In these cases, exteriorizing the bowel may be readily done through a transverse or Pfannenstiel incision. In LRHC, bowel exteriorization and EA is most easily and safely done through the midline as the incision can be extended without difficulty to accommodate bulky mesenteries or control bleeding if traction injuries occur. Anatomic constraints generally preclude EA through a low transverse incision.

In our study, there were 6 cases (21%) of extraction site hernias in the EA group and 1 case (5%) of port site hernia in the IA group at follow-up. All of the patients with extraction site hernias in the EA group were symptomatic and underwent definitive repair. The port site hernia was asymptomatic and smaller than 1 cm and was noted only by the examining surgeon. It has been included in this report for full transparency. The patient did not proceed to surgical correction. These data support the use of IA with transverse extraction sites in relation to reduced hernia rates.

There are few other data addressing hernia formation specifically in LRHC with IA. Facy and colleagues[24] reported a 2.4% hernia rate (2 of 82) in their series of patients who underwent LRHC with IA. There was no comparison group in their review.

Perceived disadvantages for LRHC with IA may include the necessity of intracorporeal suturing techniques and increased use of operating room resources, such as use of endoscopic staplers. Although intracorporeal laparoscopic suturing is a novel skill for many surgeons, it should be emphasized that this study occurred at an urban teaching hospital where the majority of procedures are completed by senior surgical residents under the supervision of laparoscopic surgeons with no need for conversion for intraoperative complications or for inability to complete the anastomosis. We contend that surgeons can use intracorporeal suturing techniques efficiently after a period of appropriate mentorship. There was no difference in duration of surgery or use of resources other than endoscopic staplers. Although our study did not involve a cost analysis, one can estimate an increased direct cost of endoscopic staplers of approximately $1064 per case based on current price structures. This cost is offset by shorter LOS based on previous investigation in our region ($1920/d[25]). This savings would be compounded if reoperation for hernia repair were considered.

We believe that LRHC with IA has other advantages over EA that were not specifically assessed in this study; LRHC with IA allows the surgeon to have constant, direct vision of the entire surgical field. This may minimize potential bowel orientation errors while performing ileocolic anastomosis. In addition, IA may reduce the risk of microlacerations associated with increased manipulation and traction, thereby potentially increasing the success of the anastomosis[26] and reducing postoperative ileus. This is particularly important in an ever-increasingly obese population, as these patients have larger specimens with heavy, fatty mesenteries and much thicker abdominal walls.

Limitations

In this retrospective chart review we were unable to determine whether patients in whom hernias developed had significantly greater risk factors, such as obesity or wound complications, as this information was variably recorded. In addition, the groups were dissimilar in that there were substantially more invasive lesions removed from the EA than the IA group on final pathology (Table 3). Preoperatively there had been no significant difference between the groups (Table 1). This would not impact the surgeon's preoperative decision to perform either an IA or an EA, as an invasive lesion is not a contraindication to either anastomosis technique. There were no conversions from IA to EA over the review period.

Finally this retrospective study was nonblinded and had a relatively small sample size. This could influence results, especially if there were changes in the perioperative management during the 21-month study period. Although the institution did not use a specific perioperative care map at the time, early ambulation, enteral feeding, aggressive pain management and judicious use of intravenous fluids have been embraced since before the period in question. We do not believe there were clinically important changes in patient care plans during this time.

Conclusion

We found that LRHC can be performed safely with either IA or EA. Whereas an IA requires advanced laparoscopic suturing skills, it is a feasible procedure that has the advantage of a less hernia-prone Pfannenstiel extraction site with faster recovery and reduced LOS. We believe that LRHC with IA offers substantial advantages to

patients and should be offered by surgeons who have been adequately mentored in this procedure.

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