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ORIGINAL SCIENTIFIC REPORT

Laparoscopic Versus Open Loop Ileostomy Reversal: Is there an Advantage to a Minimally Invasive Approach?

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Abstract

Background Ileostomy reversals are commonly performed procedures after colon and rectal operations. Laparoscopic ileostomy reversal (LIR) with lysis of adhesions has potential benefits over conventional open surgery. The aim of this study was to compare outcomes of laparoscopic and open ileostomy reversal.

Methods 133 consecutive patients undergoing ileostomy reversal at our institution between June 2009 and August 2013 were analyzed using a retrospective database. The group comprised 53 laparoscopic cases and 80 open cases, performed by four surgeons at a single center. The data were analyzed for patient demographics, operative characteristics, postoperative outcomes, and 30-day morbidity and mortality.

Results The two groups had comparable mean age, gender distribution, ASA scores, and BMI. The laparoscopic group had a significantly longer duration of surgery compared to the open reversal group (109 versus 93 min, $p < 0.05$). However, this group underwent more lysis of adhesions (60.4 % versus 26.3 %, $p < 0.01$) as well as concurrent stoma site mesh reinforcement (32.1 % versus 6.3 %, $p < 0.01$). In the laparoscopy group, 20.7 % of patients underwent intra-corporeal ileo-ileal anastomosis. There were no significant differences between the laparoscopic and open groups with regard to estimated blood loss (31 versus 40 ml, respectively) or mean length of stay (5.3 vs. 5.7 days, respectively). The rates of overall 30-day morbidity (16.9 % for laparoscopic vs. 21.3 % for open) as well as rates of specific complications were equivalent between groups. 30-day mortalities were not noted in either group.

Conclusion LIR is safe and effective with low perioperative morbidity and mortality. The use of laparoscopy as an option in terms of concomitant hernia repair and lysis of adhesions may be considered in selected patients.

Introduction

Ileostomy creation and fecal diversion can help reduce the incidence and morbidity associated with anastomotic leak [1, 2]. As a result, ileostomy construction is a common adjunct to many colorectal operations. However, ileostomy reversal has the potential for significant complications, with reported morbidity and mortality rates of 17–20 and 0.4 %, respectively [3]. Dehydration, acute renal failure, skin excoriation, stoma retraction, stenosis, prolapse,

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parastomal hernia formation, and bleeding have all been reported as complications of ileostomy or ileostomy takedown [4–6]. Complications such as anastomotic leak, intra-abdominal abscess, sepsis, and multi-organ dysfunction can also occur and are potentially life threatening [3, 7–11]. Therefore, ileostomy construction is used selectively in patients with an increased risk of anastomotic leak [12].

Ileostomy reversal is typically an elective procedure and opinions vary on the most ideal timing for operation [13–16]. Recently, there has been a trend toward earlier closure at approximately 8–10 weeks after initial construction. An open technique has conventionally been used for reversal. The exteriorized loop of bowel is dissected from the abdominal wall; the stoma site resected and the afferent and efferent loop anastomosed. Additional procedures such as lysis of intra-abdominal adhesions and the repair of parastomal hernia may be done at the same time, if indicated.

Laparoscopic ileostomy reversal (LIR) is an increasingly used modality, with potential benefits over conventional open surgery [17]. The improved visualization makes identification and repair of coexistent parastomal hernia and lysis of adhesions easier [18, 19]. In many other surgical procedures, laparoscopy has proven to be beneficial with regard to outcomes [19, 20]. The aim of this study was to compare operative and postoperative outcomes of laparoscopic versus open ileostomy reversal.

Materials and methods

A retrospective review was performed for patients undergoing ileostomy reversal at our institution between June 2009 and August 2013. Procedures included laparoscopic and open approaches. Open reversal was utilized in 80 cases and LIR was performed in 53 cases. Laparoscopic ileostomy closures were standardized in the following manner for an ileostomy located on the right abdomen (as in Fig. 1): after obtaining pneumoperitoneum with a Veress needle in the left subcostal region, three trocars were placed along the left anterior axillary line. Lysis of adhesions around the stoma, if any, was performed sharply. In selected patients, the proximal and distal limbs were divided laparoscopically; a side-to-side intra-corporeal anastomosis was performed with an articulating 60-mm endoGIA stapler, and the enterotomy was closed with a running 3-0 absorbable suture. Finally, a parastomal incision along the outer abdominal wall was made down to the level of the abdominal fascia and the stoma remnant was removed. Open reversal was performed through the ileostomy site or midline incision, depending on surgeon preference.

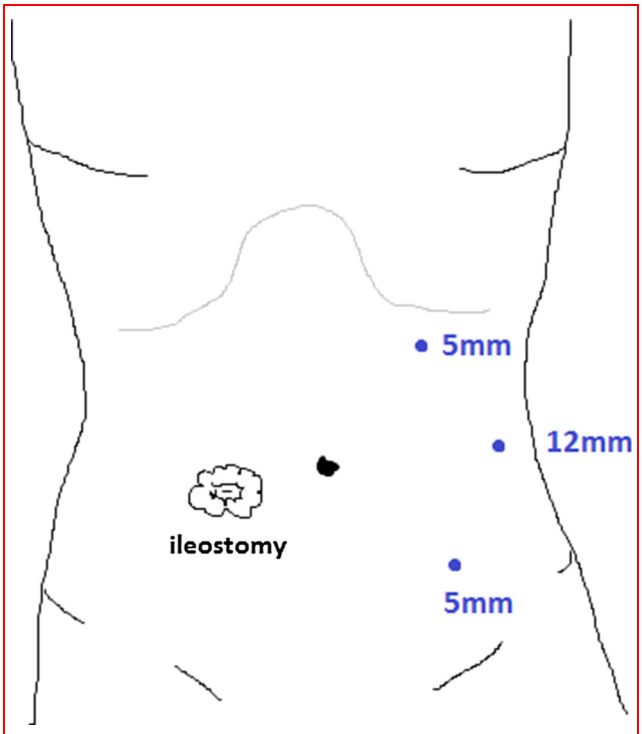

Fig. 1 Port placement for laparoscopic ileostomy reversal

Preoperative parameters that are analyzed included age, gender, American Society of Anesthesiologists (ASA) physical status classification, and body mass index (BMI). Comorbidities that are studied included diabetes mellitus, hypertension, chronic kidney disease, hypothyroidism, cardiac disease, and smoking. Operative parameters included operative time, estimated blood loss (EBL), whether lysis of adhesions was performed, duration of adhesiolysis, stoma site reinforcement, type of skin closure, and conversion to open surgery. In the laparoscopic group, the type of intestinal anastomosis, intra versus extra-corporeal, was also noted. Selected patients in both groups underwent stoma site reinforcement with placement of a single biologic mesh at the old stoma site as determined by the surgeon. Our practice involves the selective use of a biologic mesh to reinforce the ileostomy defect at the time of reversal in certain patients, including all patients with obesity, history of smoking, or diabetes. Patients who underwent open ileostomy closure and found to have a parastomal hernia were repaired either through the stoma site or midline incision, depending on surgeon preference. We utilized the Cook Biodesign porcine submucosal graft, a non-dermis, non-cross-linked biologic mesh with dimensions of 13×15 cm^2. This graft was placed in an underlay fashion and anchored to the abdominal fascia using absorbable sutures as well as tacks. Skin closure methods include purse string, skin stapler with loose

Table 1 Characteristics and comorbidities of patients undergoing laparoscopic versus open ileostomy reversal

	Laparoscopic ($n = 53$)	Open ($n = 80$)	p value
Mean age (years, SD)	52.2 ± 15.3	51.2 ± 18.1	0.74
Gender (%)			
Male	27 (50.9 %)	42 (52.5 %)	0.99
Female	26 (49.1 %)	38 (47.5 %)	0.99
Mean BMI (kg/m^2, SD)	27 ± 7	26.3 ± 6.3	0.55
Mean ASA Class (class, SD)	2.6 ± 0.5	2.5 ± 0.7	0.37
Diagnosis of cancer (%)	36 (67.9 %)*	37 (46.2 %)	0.02
Chemotherapy (%)	26 (49.1 %)*	23 (28.8 %)	0.03
Radiation therapy (%)	14 (26.4 %)	14 (17.5 %)	0.28
Mean duration of ileostomy (days, SD)	217 ± 456	152 ± 180	0.25
Index Procedure			
Open (%)	6 (11.3 %)*	21 (26.3 %)	<0.05
Laparoscopic (%)	17 (32.1 %)*	45 (56.3 %)	0.01
Robotic-assisted (%)	30 (56.6 %)*	14 (17.5 %)	<0.01
Comorbidities			
Diabetes mellitus (%)	9 (17.0 %)	11 (13.8 %)	0.81
Hypertension (%)	18 (34.0 %)	31 (38.8 %)	0.58
Chronic kidney disease (%)	0 (0 %)	1 (1.3 %)	0.99
Hypothyroidism (%)	4 (7.55 %)	8 (10.0 %)	0.76
Cardiac disease (%)	2 (3.8 %)	7 (8.8 %)	0.31
Smoking (%)	3 (5.7 %)	9 (11.3 %)	0.36

* $p < 0.05$

packing, and no closure. Purse string closure method consisted of running absorbable suture along the dermal layer; skin stapler closure included placement of skin staples widely spaced apart with placement of loose packing strips in between. The choice of skin closure method was dependent on surgeon preference, and independent of procedure type (laparoscopic versus open method) and the presence of mesh.

Anastomotic leaks were defined radiologically using computed tomography (CT) scan with oral contrast. Postoperative abscesses were diagnosed by the presence of fluid collections on CT scan in symptomatic patients with intact stoma anastomosis. Morbidity and mortality were recorded for a period of 30 days postoperatively. Complications that are analyzed included urinary tract infections, ileus, sepsis, cardiac complications, superficial surgical site infections (SSI), intra-abdominal abscess, and anastomotic leak. 30-day readmission rates were also reviewed. Postoperative ileus was defined as symptomatic patients with abdominal distension and the inability to tolerate oral diet requiring insertion of a nasogastric tube.

Quantitative data were given as a mean with standard deviations. Results of the two surgery groups were compared using the independent sample t test for continuous variables and the cross-table Pearson χ^2 test for categorical variables. p values <0.05 were considered statistically significant. GraphPad Software, Inc. was used for calculations. IRB approval was obtained (UCI IRB HS#2008-6451).

Results

Patient demographics were similar between groups; no significant differences were noted in mean age, gender, BMI or ASA class (Table 1). Cancer was the index diagnosis in significantly more patients undergoing LIR compared to open reversal (67.9 vs. 46.2 %, respectively, $p = 0.02$). LIR patients also underwent more chemotherapy (49.1 vs. 28.8 %, $p = 0.03$); there was no difference in rate of radiotherapy between the two groups (17.5 vs. 26.4 %, $p = 0.28$). There was no significant difference in the mean duration of ileostomy between the two groups (217 vs. 152 days, $p = 0.25$). The index procedure was categorized as being performed open, laparoscopic or robot-assisted. When the index procedure was performed with robotic assistance, there were significantly more laparoscopic ileostomy reversals performed (56.6 %

Table 2 Operative characteristics and postoperative outcomes of patients undergoing laparoscopic versus open ileostomy reversal

	Laparoscopic ($n = 53$)	Open ($n = 80$)	p value
Operative characteristics			
Estimated blood loss (mL, SD)	31 ± 32	40 ± 81	0.44
Lysis of adhesions performed (%)	32 (60.4 %)*	21 (26.3 %)	<0.01
Lysis of adhesions duration (h, SD)	1.1 ± 1.0*	2.0 ± 1.4	<0.01
Stoma site reinforcement (%)	17 (32.1 %)*	5 (6.3 %)	<0.01
Operative time (min, SD)	109 ± 45*	93 ± 46	<0.05
Type of closure			
Purse string (%)	47 (88.7 %)	62 (77.5 %)	0.11
Stapled with loose packing (%)	0 (0 %)	5 (6.3 %)	0.08
Left open (%)	6 (11.3 %)	6 (7.5 %)	0.55
Postoperative outcomes			
Mean length of stay (days, SD)	5.3 ± 4	5.7 ± 4.6	0.61
30-day mortality (%)	0 (%)	0 (%)	0.99
30-day morbidity (%)	9 (16.9 %)	17 (21.3 %)	0.66
Readmission rate (%)	4 (7.6 %)	7 (8.8 %)	0.99
Urinary tract infection (%)	3 (5.7 %)	2 (2.5 %)	0.39
Ileus (%)	5 (9.4 %)	10 (12.5 %)	0.78
Sepsis (%)	0 (0 %)	3 (3.8 %)	0.28
Cardiac complication (%)	1 (1.9 %)	2 (2.5 %)	0.99
Superficial SSI (%)	0 (0 %)	2 (2.5 %)	0.52
Intestinal obstruction	1 (1.9 %)	1 (1.3 %)	0.99
Abscess (%)	2 (3.8 %)	5 (6.3 %)	0.70
Anastomotic leak (%)	1 (1.9 %)	4 (5.1 %)	0.65

* $p < 0.05$

laparoscopic closure versus 17.5 % open closure, $p < 0.01$). Both laparoscopic and open index procedures had a significantly larger number of open ileostomy closures. Index procedures of LIR were open in 6 cases (11.3 %), laparoscopic in 17 cases (32.1 %), and robotic-assisted in 30 cases (56.6 %) ($p < 0.01$). Similarly, index procedures of open reversal cases were open in 21 cases (26.3 %), laparoscopic in 45 cases (56.3 %), and robotic-assisted in 14 cases (17.5 %) ($p < 0.05$). No significant difference was noted between the two groups in any of the comorbidities analyzed including diabetes mellitus, hypertension, chronic kidney disease, hypothyroidism, cardiac disease, and smoking.

Operative characteristics and postoperative outcomes are listed in Table 2. 79.6 % of patients within the laparoscopic group had extra-corporeal anastomoses and 20.4 % had anastomoses created in an extra-corporeal fashion. Intra-corporeal anastomosis was performed based on surgeon preference and clinical indication, including patient's body habitus when exteriorization of bowel was more difficult due to reach. No difference was noted in EBL (31 ml laparoscopic vs 40 ml open, $p = 0.44$). At our institution, it is our practice to document the time allotted for adhesiolysis during the case. Location of adhesions varied between the abdominal wall and in between bowel loops. All visualized intra-abdominal adhesions directly involved with the stoma reversal were taken down in both groups. We do not support incidental adhesiolysis. Adhesion barriers are not routinely used at our institution. Lysis of adhesions was performed in significantly more LIR (60.4 vs. 26.3 %, $p < 0.01$), and mean time for adhesiolysis was shorter in the laparoscopic group (1.1 h LIR vs. 2 h open, $p < 0.01$). Concomitant stoma site reinforcement was also more common in the laparoscopic group (32.1 % LIR vs. 6.3 % open, $p < 0.01$). Four patients with parastomal hernias in the open group underwent repair through the preexisting stoma site, two patients underwent repair through the midline incision, and all cases of open parastomal hernias were repaired primarily due to increased complexity and associated morbidity in open repair. Both the method of open repair and decision for primary versus mesh repair were at the discretion of the operating surgeon. LIR had a longer operating time on average compared to open reversal (109 vs. 93 min, $p < 0.05$). Skin closure was

categorized into purse string, skin stapler with loose packing, and no closure. The majority of wounds were closed by a purse string approach in both open and laparoscopic groups (88.7 and 77.5 %, respectively). There were no significant differences in closure type between groups.

Postoperative outcomes were comparable after laparoscopic compared to open ileostomy reversal. Incidence of anastomotic leaks and abscesses was higher in the open group; however, the differences were not significant (Table 2). No differences were noted in mean length of stay, overall 30-day morbidity, 30-day mortality or 30-day readmission (Table 2). Similarly, no significant differences were found for specific complications between the laparoscopic and open groups.

Discussion

Diverting ileostomies are the important component in the surgical management of lower gastrointestinal malignancy. Utilizing an ileostomy to protect a newly constructed intestinal anastomosis is widely accepted [1, 2]. However, living with an ileostomy does have some psychosocial and economic drawbacks [21–24]; therefore, ileostomy closure is attempted in the vast majority of patients [25]. The operative technique of choice for ileostomy reversal is still a topic of debate. The morbidity associated with conventional open techniques has been documented in several studies and ranges from 17 to 20 % [3, 9–11, 15]. From our own institutional practice with four experienced laparoscopic colorectal surgeons, we have found that the learning curve is relatively short, averaging about 5–10 cases for intra-corporeal anastomosis and almost nil for adhesiolysis with extra-corporeal anstomosis according to our experience. Laparoscopy has been increasingly used with several potential advantages; however, there is a lack of information regarding the outcomes of laparoscopic compared to open ileostomy reversal. Previous studies have been limited by small groups, such as Royds et al. [19] who examined 74 patients in 2013 and Russek et al. [18] who described 24 patients undergoing laparoscopic loop ileostomy reversal in 2011. In this retrospective study, we present the largest series published to date, consisting of 133 patients undergoing laparoscopic versus open ileostomy reversal.

Open ileostomy reversals were more likely to have had a laparoscopic or open index procedure. Laparoscopic ileostomy reversals were more likely to be preceded by a robotic-assisted index procedure. This discrepancy may be attributed to the increasing use of robotics at our institution over the study period, as well as a growing preference for minimally invasive procedures overall. The average duration of ileostomy was longer in the laparoscopic group, likely associated with more patients with a cancer diagnosis undergoing adjuvant chemotherapy; however, this difference was not significantly different between the two groups ($p = 0.25$). Mean duration of ileostomy for patients undergoing open reversal was 152 days and for those undergoing laparoscopic reversal was 217 days. These periods are longer than the generally accepted timeframe for ileostomy closure set at roughly 8–10 weeks (56–70 days) [14, 16, 26].

Lysis of adhesions was significantly more common in laparoscopic cases as compared to open (60.4 vs. 26.3 %, respectively). One possible reason for the higher rate of adhesiolysis in the LIR group may be due to enhanced visualization that laparoscopy provides. Average time spent on adhesiolysis was shorter in the laparoscopic group compared to the open group (1.1 vs. 2.0 h, respectively). The degree of adhesions was difficult to quantify. However, we have found that index laparoscopic or robotic procedures led to fewer adhesions compared to open surgery, likely from laparoscopy producing less peritoneal trauma compared to the traditional laparotomy, resulting in reduced adhesion formation. In our practice, LIR is routinely considered a surgical option in patients with minimally invasive surgery at the index operation. Longer time spent on adhesiolysis in the open group is likely due to increased presence of complex adhesions resulting from complicated index operations. Overall, placement of working laparoscopic ports did not require more extensive adhesiolysis than otherwise required. Laparoscopic lysis of adhesions has been shown to be beneficial in several other studies, which is an added advantage of this technique [17, 18, 27]. Concomitant stoma site reinforcement with mesh is another advantage to a laparoscopic approach. Subsequent hernia at the ileostomy site following reversal is common and has been reported to occur in up to 30 % of patients [28–30], with up to half requiring surgical repair [28]. Furthermore, Rosen et al. [31] demonstrated a 5-year experience of single-staged repairs of infected and contaminated abdominal wall defects utilizing biologic mesh with reported acceptable safety and lower recurrence rates of hernia. Thus, both laparoscopic and open ileostomy groups underwent reinforcement with mesh at the discretion of the operating surgeon. However, when comparing the two groups, more patients undergoing LIR had mesh placement (32.1 vs 6.3 %). Laparoscopy allows for enhanced visualization of the defect and closure with an underlay mesh, and this may explain the higher utilization of mesh reinforcement in this group. Less frequent use of mesh reinforcement during open stoma reversal may be due to increased perceived difficulty and increased morbidity associated with larger incisions and prolonged operating time [32]. Utilization of mesh was considered in

patients with risk factors for hernia and with parastomal hernias. We prefer to use biologic prosthesis over synthetic for mesh reinforcement, as stoma reversal is considered a contaminated procedure. The fact that these procedures were performed in addition to ileostomy reversal may account for the longer operating time in the laparoscopic group. In this study, LIR showed no significant difference in length of stay. This contradicts data published by Royds et al. [19] which demonstrated earlier return of bowel function and discharge in LIR. One of the reported benefits of many laparoscopic procedures is a shorter duration of stay. The fact that we did not find a difference in length of stay may be due the additional procedures performed, such as the lysis of adhesions and stoma site reinforcement. Also, because all stoma closures require a local incision at the ostomy site, patients undergoing laparoscopic repair will still require postoperative pain management.

Overall morbidity was not significantly different between groups (16.9 % LIR vs. 21.3 % open, $p = 0.66$). These rates are comparable to a large systematic review by Chow et al. [3] who found an overall morbidity rate of 17.3 %, as well as a large single institution series from Luglio et al. [9] reporting a morbidity rate of 21.5 %. The most frequent complication seen in our patients was ileus which occurred in 11 % of patients overall. There was no difference in ileus rates between groups. Only two patients developed a superficial SSI, both of which occurred in the open group. This low rate of infectious complications was likely related to the method of closure at the stoma site. Our most frequent closure technique was a purse string closure. This was adopted after several studies demonstrated an acceptable and often lower infection rate with purse string closure [33–35]. Prior to this technique the wounds were occasionally left open or closed loosely with skin stapler with loose packing placed between. Readmission was not significantly different between groups (7.6 % laparoscopic vs. 8.8 % open) and overall rates are comparable to other series [36]. No mortality occurred in either group within our study.

There are several limitations that are important to mention. First, the use of laparoscopy may lead to higher overall costs. However, this was not examined in the context of this study. An increase in costs may potentially be offset by a shorter length of hospital stay or decreased morbidity, as seen in other institutions [19]. Our study did not show a significant difference in these findings. Cost analysis was not our main focus, and as a result was not analyzed. Therefore, we feel that larger prospective trials with cost analysis are required to fully evaluate these factors. Second, as a single institution study and retrospective study, there may be an element of selection bias as specific factors such as operative technique and use of mesh prosthesis were at the discretion of the surgeon. Finally, additional studies are necessary to determine long-term outcomes of hernia formation or bowel obstruction after ileostomy reversal.

Conclusion

We found LIR to be safe and effective with similar morbidity to open reversal. At our institution, LIR was considered in patients after open, laparoscopic or robotic surgery at the index operation. The use of laparoscopy allows for easier stoma site reinforcement and lysis of adhesions. Although LIR was associated with longer operative times, the additional procedures performed may provide long-term benefits. Larger prospective trials are required to further confirm these findings and examine long-term outcomes.

Compliance with ethical standards

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