Journal of Pediatric Surgery (2013) **48**, 1546–1550

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Journal of Pediatric Surgery

www.elsevier.com/locate/jpedsurg

Comparison of laparoscopic-assisted and open total proctocolectomy and ileal pouch anal anastomosis in children and adolescents

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Received 3 July 2012; revised 24 August 2012; accepted 28 August 2012

Key words:
Laparoscopy;
Restorative proctocolectomy;
Pediatric;
Ulcerative colitis;
Small bowel obstruction

Abstract

Background: Laparoscopic techniques have been applied to restorative proctocolectomy since the early 2000's. We have employed a technique for laparoscopic-assisted total proctocolectomy (TPC) and ileal pouch anal anastomosis (IPAA) for the treatment of children with ulcerative colitis (UC).

Methods: We retrospectively reviewed 68 laparoscopic-assisted TPCs and 39 open TPCs performed at our institution for UC between January 1997 and February 2011. Case duration, postoperative length of stay, and complications of the two groups were compared, and multivariable analysis was applied.

Results: The two groups were comparable with respect to gender, age, and postoperative length of stay. Total abdominal colectomy (TAC) duration was significantly longer in the laparoscopic-assisted group ($P < .001$). Complications were similar in the laparoscopic and open group, although small bowel obstruction (SBO) was significantly less frequent in the laparoscopic group (log-rank test = 8.88, $P = .003$). Kaplan–Meier estimated freedom from SBO at 1 year follow-up is 99% for patients treated laparoscopically (95% CI: 98%–100%) and 76% for those undergoing an open surgical approach (95% CI: 64%–88%).

Conclusions: The significantly lower SBO rate, low complication rates, and equivalent length of stay favor use of the laparoscopic-assisted approach for TPC and IPAA in children.

The application of laparoscopic techniques to restorative proctocolectomy (RP) represents the most recent step in the evolution of the surgical management of ulcerative colitis (UC). Although advanced laparoscopic operations may be technically more challenging with longer operative times, overall laparoscopy has been shown to result in decreased postoperative length of stay, fewer major wound complications, and fewer postoperative adhesions [1-3]. The purpose of this study was to compare the outcomes of the laparoscopic approach with the open approach in the surgical management of UC in children and adolescents.

1. Methods

We retrospectively reviewed consecutive laparoscopic-assisted total proctocolectomy (TPC) cases and consecutive

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0022-3468/$ – see front matter © 2013 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.jpedsurg.2012.08.031

open TPC cases performed at our institution between January 1997 and February 2011. Patients were identified using billing database and hospital charts. This report was developed with the approval of the Institutional Review Board at Boston Children's Hospital (M10-03-0140). Patients managed in an open fashion underwent operations between January 1997 and July 2004. Laparoscopic-assisted cases were performed starting in June 2003, and the laparoscopic approach has been used for every patient in need of RP since July 2004. All cases reviewed were performed by the same three surgeons. Patients undergoing operations for diagnoses other than UC were excluded from this study.

Restorative proctocolectomy was performed in two or three stages. Patients with well controlled colitis were treated in two stages with a combined TPC and ileal pouch anal anastomosis (IPAA) followed by subsequent ileostomy closure. Other patients were treated in three stages, where a total abdominal colectomy (TAC) was performed, followed by a completion mucosal proctectomy and IPAA when their medical condition improved. A temporary, completely diverting, ileostomy was always employed, and closed as the final operation. Demographic, procedural, and medication data were collected, as were outcome data such as case duration, postoperative length of stay, and complications.

1.1. Statistical analysis

Laparoscopic and open study groups were compared with Student's *t*-test for age and case duration. Fisher's exact test was used for gender, two-stage versus three-stage, specific types of medications, complications, anoplasties, and development of small bowel obstruction (SBO). Median length of stay (LOS) was compared using the nonparametric Mann–Whitney *U*-test. The Kaplan–Meier product–limit method was applied to assess time to SBO, with laparoscopic and open groups compared by the log-rank test and 95% confidence intervals around the curves determined by Greenwood's formula [4].

The multivariable Cox proportional-hazards regression model was utilized to evaluate whether occurrence of SBO was significantly different between the laparoscopic and open groups after adjustment for covariates including planned operation (two-stage vs. three-stage) and surgical case duration [5]. We applied a relaxed rule for the number of covariates in the multivariable model since there were only nine patients who developed SBO and therefore limited the analysis to three variables to ensure reliable regression coefficients [6].

Fisher's exact test was used to compare the distribution of two-stage versus three-stage in the open and laparoscopic group in subgroup analysis. Multivariable Cox model and Kaplan–Meier methods were also applied to the subgroup analysis to assess whether the occurrence of SBO was significantly associated with surgical procedure independent of any potential historical biases due to different time epochs. Two-tailed values of $P < .05$ were considered statistically significant. Statistical analysis was performed using the SPSS software package (version 19.0, SPSS Inc./IBM, Chicago, IL).

2. Results

We reviewed a total of 68 consecutive laparoscopic-assisted TPCs and 39 consecutive open TPCs performed for UC patients. Laparoscopic and open groups did not significantly differ in age at operation or gender (Table 1). A smaller percentage of laparoscopic patients compared to open surgery patients had a three-stage procedure (28% vs. 54%, $P = .01$). More patients in the laparoscopic group were on Remicade (22% vs. 3%, $P = .005$) or on Tacrolimus (63% vs. 18%, $P = .001$) preoperatively. Total abdominal colectomy duration was significantly longer in the laparoscopic group ($P < .001$). Complications were similar between the laparoscopic and open groups, although patients who had open operations had a significantly higher rate of SBO (23% vs. 3%, $P = .002$) (Table 2). Median postoperative lengths of stay (6 days for TAC, 7 days for IPAA) were comparable in the two groups.

Kaplan–Meier analysis revealed that freedom from SBO was significantly different between laparoscopic and open

Table 1 Demographics, procedural data and medications in the two study groups.

Characteristic	Laparoscopic (n = 68)	Open Surgery (n = 39)	*P* value
Gender			.16
Female	30 (44%)	23 (59%)	
Male	38 (56%)	16 (41%)	
Procedure			.01 *
Two-stage	49 (72%)	18 (46%)	
Three-stage	19 (28%)	21 (54%)	
Age at Operation, years			
Age at subtotal colectomy	14.2 ± 3.3	13.8 ± 4.4	.72
Age at IPAA	13.8 ± 4.0	14.7 ± 4.1	.30
Case Duration, min			
TPC + IPAA	517 ± 119	430 ± 101	.008 *
Proctectomy + IPAA	423 ± 86	393 ± 88	.29
TAC	328 ± 91	222 ± 34	< .001 *
Use of Steroids and Immunosuppression			
Remicade	15 (22%)	1 (3%)	.005 *
Tacrolimus	43 (63%)	7 (18%)	.001 *
Steroids	49 (72%)	33 (85%)	.16
None	2 (3%)	3 (8%)	.35

Age and case duration are mean ± standard deviation. TPC = total proctocolectomy; IPAA = ileal pouch anal anastomosis; TAC = total abdominal colectomy.

* Statistically significant.

Table 2 Comparison of complications and length of stay between the two study groups.

Outcome	Laparoscopic (n = 68)	Open Surgery (n = 39)	*P* value
Minor Complications			
Stoma revisions	5 (7%)	3 (8%)	1
Pancreatitis	0 (0%)	2 (5%)	.13
Port site hernia	1 (1%)	NA	–
Superficial wound infection	0 (0%)	1 (3%)	.36
Major Complications			
Duodenal injury	1 (1%)	0 (0%)	1
Small bowel injury	1 (1%)	0 (0%)	1
Bilateral leg CS	0 (0%)	1 (3%)	.36
Anoplasty [a]	9 (13%)	11 (28%)	.07
SBO	2 (3%)	9 (23%)	.002 *
Postop LOS, median (range), days			
IPAA	7 (5–21)	7 (5–14)	.27
TAC	6 (4–25)	6 (4–10)	.67

CS = compartment syndrome; SBO = small bowel obstruction; LOS = length of stay; IPAA = ileal pouch anal anastomosis; TAC = total abdominal colectomy; NA = not applicable.

* Statistically significant, Fisher's exact test.

[a] 10 total anoplasties in the laparoscopic group and 16 total in the open surgery group.

groups (log-rank test = 8.88, P = .003) such that the nine patients who had SBO in the open surgery group all developed SBO within the first year, whereas the two patients who had SBO in the laparoscopic group developed SBO at 1 month and at 4 years post procedure (Fig. 1). Kaplan–Meier estimated freedom from SBO at 1 year follow-up is 99% for patients treated laparoscopically (95% CI: 98%–100%) and 76% for those undergoing an open surgical approach (95% CI: 64%–88%).

Since laparoscopic and open surgery patients differed with respect to the number of stages, a multivariable approach was applied to account for this imbalance and any possible influence of case duration to objectively compare the two approaches regarding development of SBO. Results of the multivariable Cox proportional hazards regression analysis confirmed that the only significant independent predictor of SBO was open technique compared to laparoscopic. This suggested a higher monthly risk of SBO for patients undergoing open surgery independent of the number of stages and case duration (hazard ratio = 7.4, 95% CI: 2.1–35.6, P = .003). Number of stages (P = .72) and case duration (P = .86) were not statistically significant by multivariable Cox analysis. The stage-by-surgical approach interaction term was not significant (P = .56), indicating that the advantage of the laparoscopic approach in significantly reducing the risk of SBO holds for both two-stage and three-stage procedures.

Subgroup group analysis excluded 13 open cases performed prior to 2000 and compared the same 68 laparoscopic cases to the 26 open cases performed since 2000 (N = 94 patients). There were 16 two-stage (62%) and 10 three-stage (38%) in the open group, which was more comparable to the laparoscopic group (49 two-stage: 72%, 19 three-stage: 28%), and Fisher's exact test indicated no difference between the groups (P = .33). Furthermore, the results of this subgroup analysis were consistent with the full analysis, showing a significant difference between the groups based on area under the Kaplan–Meier curves (log-

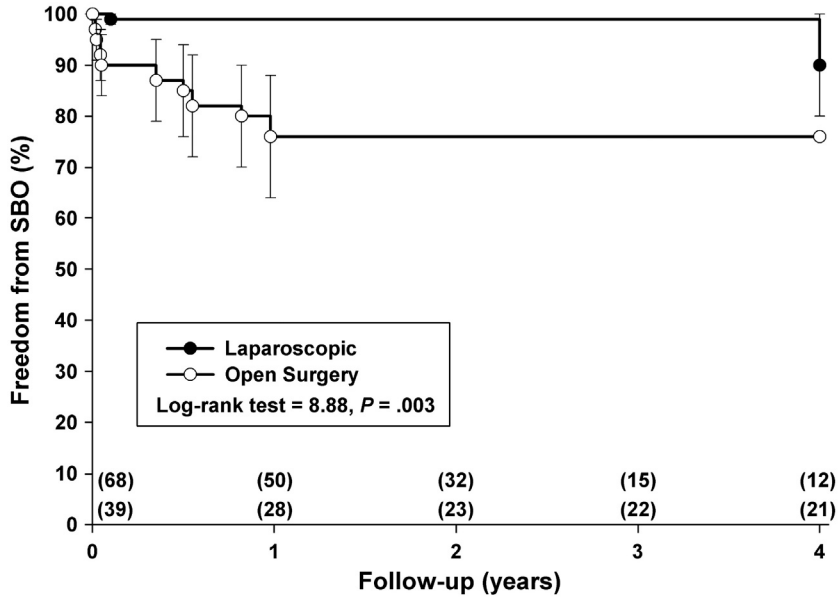

Fig. 1 Kaplan–Meier time-to-event curves showing the expected percentage of patients free of small bowel obstruction during the follow-up. Patients in the open group developed SBO more often and earlier compared to patients in the laparoscopic group (log-rank test = 8.88, P = .003). Error bars denote 95% confidence intervals. The numbers in parentheses represent the number of patients in the laparoscopic (top) and open (bottom) groups still in the follow-up who had not developed SBO, although remained at risk (i.e., censored data).

rank test = 7.94, P = .005). This indicated a significant difference in the percentage of patients who developed SBO between the two groups: 2 of 68 in the laparoscopic group (3%) compared to 6 of 26 in the open group (23%). In this subgroup analysis aimed at restricting the comparison between laparoscopic and open approaches to the same time period in order to rule out possible bias or learning curve effects, the multivariable Cox regression model confirmed a highly significant difference between laparoscopic and open groups (P = .008), independent of number of stages (P = .88) or case duration (P = .52) as covariates.

3. Discussion

This study describes the outcomes of laparoscopic-assisted versus open RP for treating children with UC. The two groups included in this study were comparable in characteristics, complications and postoperative length of stay. Our study confirms that the laparoscopic-assisted technique has a significantly lower rate of SBO and is associated with generally longer operative times. Despite the longer operative time, the overall length of stay is comparable between the open and laparoscopic-assisted sub-groups.

As reflected in the increase in volume of literature on the subject, laparoscopic-assisted RP has been gradually gaining acceptance among adult surgeons, although reported high volume experience from pediatric surgeons is still lacking. One of the few studies assessing the clinical outcome of laparoscopic and open RP in pediatric patients was reported by Flores et al. [1]. The authors acknowledge that the universal advantages of laparoscopy, such as improved cosmesis, shorter postoperative ileus and reduced hospital stay, are present in the laparoscopic cohort. They further emphasize the benefit of cosmesis in pediatric patients, which contributes to positive body image and psychological acceptance of the illness.

A comparable study by Tan et al. has suggested similar outcomes in operative time, blood loss, complication rate, and hospital stay for open and laparoscopic RP in children. They speculate that adoption of minimally invasive techniques may reduce adhesions following surgery [7]. One of the most recent adult studies comparing the outcomes after laparoscopic or open IPAA procedures primarily using records from the American College of Surgeons National Surgical Quality Improvement Program database shows that the laparoscopic approach to ileoanal pouch formation was associated with a significant reduction in both major and minor complications when compared with the open approach, using risk-adjusted 30-day outcomes that adjust for patient characteristics, co-morbidities, and operative approach [8].

The most common surgical complication in our series was anastomotic stricture requiring anoplasty. Anastomotic stricture is a frequent problem following IPAA [9,10]. Requirement for operative intervention may be higher in children than adults given the smaller apertures [11]. Routine laparotomy leads to a lifetime risk for SBO due to adhesions of 5% to 7% [12]. Restorative TPC has historically been associated with a higher SBO rate, presumably due to adhesions that form in response to the extensive dissection required and the length of the raw surface of the divided mesentery. It is cited as the most common early complication, and some papers have indicated that as many as 27% of patients undergoing RP will develop SBO [13,14]. In our own series, the rate of SBO occurence was 23% in patients who underwent open TPC and IPAA. Some papers have debated the rate of bowel obstruction between the two different approaches for this operation [15-17]. Our data indicate that surgical approach was the only significant independent multivariable predictor of SBO and that incidence of SBO is higher and occurs earlier in the open group.

According to Mattioli, even when faced with bowel obstructions following laparoscopic-assisted approaches, subtle changes in operative technique decreased the incidence, and the obstruction site could be treated laparoscopically [18]. The high rate of adhesion formation after this operation has also been implicated in the fertility problems historically seen in women after open TPC and IPAA [19-22]. The significantly lower SBO rate in our laparoscopic-assisted patients is a potent benefit of this approach and will hopefully be associated with improved long-term fertility [23,24].

One of the major strengths of this study was the combined experience of only three surgeons, as opposed to a larger group, with greater inherent heterogeneity. One potential limitation is that within the laparoscopic-assisted group, subtle technical and equipment changes were applied throughout the study duration. However, these changes were unlikely to induce significant differences in the outcome variables measured.

Our study has demonstrated that laparoscopic-assisted RP is a suitable option for pediatric patients given its lower rate of small bowel obstruction, comparable length of hospital stay and associated complications. Indeed, this approach may be preferred over open surgical approaches given its 20% lower incidence of SBO. Additional studies from other groups and longer follow-up of patients will be important for judging the benefits of advances in laparoscopic-assisted technology. In addition, a longitudinal study of fertility in our female patients is warranted.

Acknowledgments

The authors wish to thank the primary gastroenterologists at Boston Children's Hospital, all of whom provided superb medical care for our patients. Additionally, we acknowledge Chueh (Julia) Lien for her excellent assistance in the preparation of this manuscript.

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