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SURGICAL ENDOSCOPY
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# Laparoscopic vs open total colectomy

## A case-matched comparative study

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**Abstract**
*Background:* Open total colectomy and ileorectal anastomosis (OTC) is a major colorectal procedure which would preclude laparoscopy in many centers because of technical difficulty and the fact that laparoscopic total colectomy (LTC) takes much longer than standard laparoscopic proctosigmoidectomy (LPS). This study compares OTC with LTC and LPS.
*Methods:* In this study, 34 LTC patients (May 1999 to August 2003) were matched for age, diagnosis, operative period, and procedure with patients undergoing OTC. Patients with a previous major laparotomy were excluded from the open group. Groups were compared for gender, American Society of Anesthesiology (ASA) classification, operating time, estimated blood loss, length of hospital stay (LOS), complications including readmissions, and costs. The LPS cases were picked randomly from the laparoscopic database (every eighth patient), and the OT and LOS were noted.
*Results:* The LTC and OTC groups were matched for age (mean, 31 vs 34 years; $p = 0.2$), sex (14 vs 13 females; $p = 0.8$), ASA (8/23/3/0 vs 8/22/4/0, class 1/2/3/4). The body mass index was higher in the open group (23.8 vs 27.9; $p = 0.04$). The operating time was significantly longer (187 vs 126 min; $p = 0.0001$) and the median LOS shorter in the LTC group (3 days [IQR, 2.5–5 days] vs 6 days [IQR 4–8 days]; $p = 0.0001$). The estimated blood loss was significantly less in the LTC group (168 [50–700] ml) vs 238 [50–800] ml); $p = 0.001$, but there was no significant difference in the complication (26.5% vs 38.2%; $p = 0.4$) readmission (11.8% vs 14.7%; $p = 1.0$), reoperative rates (8.8% vs 11.8%; $p = 1.0$), or direct costs ($4,578 vs $4,562; $p = 0.3$). One LTC patient died expired on postoperative day 2 of a cardiac event. Four patients (11.8%) required conversion for obesity ($n = 2$), adhesions ($n = 1$), or intraoperative hemorrhage ($n = 1$). The operating times were 36 min longer in the LTC group than in the LPS group (151 vs 187 min; $p = 0.02$), but there was no significant difference in the LOS. (3 vs 3 days, $p = 0.2$).
*Conclusions:* The findings show that LTC provides a significant decrease in the LOS over OTC, with increased operating time, but without any change in other parameters. A laparoscopic approach to subtotal colectomy is recommended for suitable patients when an experienced team is available.

**Key words:** Total colectomy — Ileorectal anastomosis — Case-matched — Open — Laparoscopic

Laparoscopic colectomy was initially described in 1991 by Jacobs et al. [19]. It has since been applied to a variety of colorectal diseases that traditionally have been managed by the open approach. The advantages of laparoscopic colectomy include decreased blood loss, reduced postoperative pain, shorter hospital stay, fewer complications, and earlier return to a normal quality of life [4, 6, 15, 20, 25]. Despite increased operative costs, reduced total costs have been reported, largely because of the shorter hospital stay [10].

The feasibility of laparoscopic total colectomy was first established in 1992 [30]. Since then, various authors have published their laparoscopic total colectomy and proctocolectomy results for familial adenomatous polyposis, slow transit constipation, malignancy, Crohns colitis, and ulcerative colitis [1, 2, 7, 16–18, 21–23, 27, 28]. However, there has been reluctance to accept the procedure widely, even among surgeons who practice segmental laparoscopic colectomy. This hesitancy is related to several factors, but it is particularly attributable to technical difficulties encountered during dissection in multiple quadrants, difficulties in mobilizing the transverse colon, division of a large number of mesenteric vessels, difficulties with retraction of other abdominal organs, and long operative times.

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A few published reports of total colectomy and ileorectal anastomosis are available, although most of these studies report the results of the technique performed for a single diagnosis or include small numbers of patients [1, 2, 17, 21, 22, 27]. We report the results of laparoscopic total colectomy with ileorectal anastomosis or subtotal colectomy and ileosigmoid anastomosis for a variety of diagnoses and compare them with a cohort of case-matched open total colectomy patients. A third cohort of randomly picked laparoscopic proctosigmoidectomies also was included for a comparison of operative times and length of hospital stay between standard laparoscopic colectomy and laparoscopic subtotal colectomy (LTC).

## Materials and methods

After informed consent, all patients undergoing laparoscopic surgery in the authors' institution are prospectively entered into an institutional review board-approved database. The details recorded include age, gender, comorbidity, American Society of Anesthesiologists (ASA) physical status classification, body mass index (BMI), diagnosis, operative details, complications, LOS, and readmissions within 30 days of discharge. The operative details include procedure, operating time, estimated blood loss, and the reasons for conversion. The laparoscopic patients were identified from this database.

All the patients who underwent LTC between May 1999 and August 2003 were matched manually for age, diagnosis, operative period, and procedure with patients undergoing open total colectomy (OTC) who were identified on the basis of CPT codes over the same period. Only patients without a history of previous major laparotomy (excluding cholecystectomy, appendectomy, or gynecologic surgery by a lower abdominal incision) were included in both the groups. All the laparoscopic procedures were performed by two experienced surgeons (A.J.S. and C.P.D.), and all the open procedure were performed by other experienced colorectal surgeons in the authors' institution. The procedure, management, and discharge criteria were similar in both the groups as per institutional protocols, and trainees were encouraged to perform both the laparoscopic and open surgeries under supervision. The discharge criteria for both groups included tolerance of three meals without nausea or vomiting, passage of flatus and adequate pain control with oral analgesia. Discharge generally followed published criteria from the authors' department for open surgery based on a prospective randomized controlled trial between a pathway of controlled rehabilitation with early ambulation and diet and traditional postoperative care after laparotomy and intestinal resection [11].

The data collected included age, gender, ASA, BMI, diagnosis, operative procedure, operative time, LOS, estimated blood loss, complications, mortality, and readmissions within 30 days of discharge. The data were gathered by review of the patient charts, laparoscopic database, and the institutional electronic charting system (Lastword 4-TD04084, IDX Systems version 5.23, Lawrence, KS, USA). Direct costs (true hospital costs rather than billed costs) for the two groups were calculated by using the Stanford's integrated hospital cost management system and decision software (Transition Systems, Boston, MA, USA). This software provided direct cost per case for hospitalization, operating room, radiology, anesthesia, pharmacy, laboratory, intensive care unit, and nursing care. Professional costs were not included in the study, and billed costs were not calculated.

The two cohorts were compared for gender, ASA, BMI, operating time, estimated blood loss, and complications including readmissions. A third cohort of laparoscopic proctosigmoidectomy (LPS) patients was picked randomly from the laparoscopic database (every eighth LPS patient), and their operative times and the length of stay were recorded.

The LTC technique involves establishing the pneumoperitoneum through a 10-mm subumblical port using the Hasson technique. A 12-mm port is placed in the right lower quadrant, and 5-mm ports are placed in the right and left upper and left lower quadrants. The procedure involves right colonic mobilization protecting the ureters and duodenum as well as hepatic flexure takedown followed by transverse colonic dissection. In cases of benign disease, the omentum generally is elevated off the transverse colon, allowing dissection to continue in the avascular plane. The mobility and attachments of the transverse colon make this the most difficult part of the procedure. The splenic flexure and finally the left colonic dissection are followed by division at a suitable point in the rectosigmoid using an endoscopic linear stapler. The vessels then are divided either extracorporeally (for benign disease with a floppy mobile colon) or intracorporeally (for malignancy) depending on the disease process. The specimen then is exteriorized and resected through the subumbilical port. The pneumoperitoneum is reestablished after the anvil of the stapler device has been inserted into the ileal end. The anastomosis then is completed under laparoscopy and checked by insufflation of air into the rectum and inspection of the donuts.

### *Statistical analysis*

All data are presented as means ± standard error of the mean (SEM) for parametric data, and as medians (interquartile range [IQR]) for nonparametric data. The *t*-test, Wilcoxon matched pairs, Mann-Whitney *U* test, and Fisher's exact test were used appropriately to compare the significance of many differences between the groups. The GraphPad InStat version 3.00 for Windows 95 (GraphPad Software, San Diego California, USA; (http://www.graphpad.com) was used to perform statistical analysis. The data were analyzed on an intention-to-treat basis. Therefore, any of the converted cases remained in the laparoscopic group.

## Results

In the chosen period, 34 patients underwent LTC and were compared with 34 matched OTC patients (manually matched from 153 OTC patients in the same period). The two groups were well matched for age, gender, and ASA class. The BMI was significantly higher in the OTC group (14 patients with BMI > 27) than in the LTC group (3 patients with BMI > 27) (Table 1). The indications for surgery in both groups were polyposis ($n = 17$), constipation ($n = 10$), Crohn's colitis ($n = 4$), hereditary polyposis with cancer ($n = 2$), and ulcerative colitis ($n = 1$). Among the laparoscopic patients, 16 familial adenomatous polyposis (FAP) and one juvenile polyposis (JP) constituted all the patients in the polyposis group. The open group had 16 FAP cases, and one patient had multiple hyperplastic and adenomatous polyps with a family history of colon cancer. The procedures in both groups included total colectomy and ileorectal anastomosis ($n = 32$) and subtotal colectomy with ileo-sigmoid anastomosis ($n = 2$).

The comparative results are reported in Table 2. Significantly longer operating times were seen in the LTC group than in the OTC group. However, the operative time in the LTC group was 169 min for the most recent 17 patients, as compared with 204 min for the earlier cohort ($p = 0.01$). Four LTC patients (11.8%) underwent conversion to surgery open for obesity ($n = 2$), bleeding ($n = 1$) and adhesions ($n = 1$).

There were 9 complications in the laparoscopic group, including 1 mortality, and 13 in the open group. There was no statistical difference ($p = 0.43$) in the complication rates between the LTC and OTC groups (odds ratio, 0.58; 95% confidence interval, 0.2–1.6). The

**Table 1.** Demographics

| | | LTC | OTC | *p* Value |
|---|---|---|---|---|
| Age (years) | Mean ± SEM (range) | 31 ± 2.5(14-73) | 33.6 ± 2.1 (11-57) | 0.16[a] |
| Gender | | | | |
| Males | | 14 | 13 | 0.8[b] |
| Females | | 30 | 31 | |
| ASA | 1/2/3/4 | 8/23/3/0 | 8/22/4/0 | 0.9[b] |
| BMI | Mean ± SEM | 23.8 ± 0.6 | 27.9 ± 1.5 | 0.04[c] |

[a] *t*-test
[b] Chi-square test
[c] Wilcoxon test
LTC, laparoscopic total colectomy group; OTC, open total colectomy group; SEM, standard error of the mean; ASA, American Society of Anesthesiology Classification; BMI, body mass index

**Table 2.** Results[a]

| | LTC | OTC | *p* value |
|---|---|---|---|
| Operating time (range) | 187 ± 7.4 (100–300) | 126 ± 4.1 (94–193) | 0.0001[b] |
| Length of stay (range) days | 3 (2.5–5) | 6 (4–8) | 0.0001[b] |
| Operating time (LPS) min | 151 ± 18.5 | | 0.02[c] |
| Length of stay (LPS) (range) days | 3 (2–4) | | 0.2[c] |
| Estimated blood loss (range) ml | 168 ± 23.5 (50–700) | 247 ± 25.5 (50–800) | 0.001[b] |
| Complications (includes mortality) *n* (%) | 9 (26.5) | 13 (38.2) | 0.43[d] |
| Reoperations *n* (%) | 3 (8.8) | 4 (11.8) | 1.0[d] |
| Readmissions *n* (%) | 4 (11.8) | 5 | 1.0[d] |
| Costs ($) | 4,572 | 4,568 | 0.3[b] |
| Conversions | 4 | NA | |
| Reasons for conversion | Obesity 2, bleeding 1, adhesions 1 | | |

[a] Parametric data as mean ± standard error and nonparametric data as median (interquartile range)
[b] Wilcoxon matched pairs test
[c] Mann-Whitney test (LTC vs LPS)
[d] Fisher's exact test
LTC, laparoscopic total colectomy group; OTC, open colectomy group; LPS, laparoscopic proctosigmoidectomy; NA, not applicable

complications in the LTC group included anastomotic leaks ($n = 2$, requiring relaparotomy), postoperative intraabdominal hemorrhage ($n = 1$, requiring relaparotomy), postoperative ileus ($n = 2$), pulmonary complications ($n = 2$), and subacute small bowel obstruction ($n = 1$), recovered spontaneously. The complications experienced by four of these patients were diagnosed after readmission.

In the OTC group, the complications included postoperative hemorrhage ($n = 3$, two cases requiring relaparotomy and ligation of the bleeding vessel and one case with bleeding from the anastomotic site managed using endoscopic injection of the anastomotic site with 1 in 10,000 adrenaline), postoperative ileus ($n = 5$, two cases requiring parenteral nutrition), wound complications ($n = 2$), and superior mesenteric vein thrombosis ($n = 1$, managed with anticoagulation). There were no anastomotic leaks in the OTC group. However, two patients required computed tomography (CT) scan-guided drainage of pelvic abscesses. Four of these complications were diagnosed at readmission. There was no mortality in the OTC group, but there was one mortality on postoperative day 2 in the laparoscopic group, which was attributable to a cardiac event. The operative time was significantly longer for the LTC group than for the LPS group (187 vs 151 min; $p = 0.02$), but there was no significant difference in the LOS (3 vs 3 [IQR 2–4] days; $p = 0.2$).

## Discussion

Total colectomy with ileorectal or ileosigmoid anastomosis is indicated for patients with slow-transit constipation [3, 29] and also for patients with FAP, Crohn's colitis, and mucosal ulcerative colitis with rectal sparing. At the author's institution, total colectomy with ileorectal anastomosis is performed for a select group of FAP patients with relative rectal sparing. The criteria for the selected patients require fewer than 20 polyps, no associated colon cancer, and sufficient reliability to return for a 6-month visit and then early follow-up visits) [8]. Preservation of the rectum in these patients helps to preserve a relatively normal bowel habit with minimal or no dietary restriction and minimizes the risk of pelvic nerve damage [9, 24].

Laparoscopic total colectomy with ileorectal or ileosigmoid anastomosis for slow-transit constipation, FAP, and mucosal ulcerative colitis have been reported in the literature [1, 2, 17, 21, 22, 27]. Mean operating times are reported to range between 172 and 358 min and LOS between 5 and 10 days, whereas morbidity is

**Table 3.** Comparison of previous studies on total colectomy

| Author | Indication | Type of procedure | No. of patients | Operative time (min) | Conversion (%) | LOS (days) | Morbidity (%) |
|---|---|---|---|---|---|---|---|
| Lointior [21] | MUC/FAP/STC | Total colectomy with IRA | Lap 6 | 358 | — | 10.1 | 16.6 |
| Milsom [22] | FAP | Total colectomy with IRA | Lap 16 | 232 | 0 | 5 | 12.5 |
| Ho [7] | STC | Total colectomy with IRA | Lap 7 | 172 | — | 10.6 | 23 |
| | | | Open 17 | 98 | | 9.2 | 43 |
| Araki [1] | MUC/FAP | Total colectomy with IRA | Lap 10 | 282 | | | |
| | | | Open 29 | 274 | | | |
| Seshadri [27 | MUC/CD/FAP/Cancer | Total colectomy (TAC) | Lap 37 | 270 | TAC 8 | 6 | 24 |
| | | | Open 36 | 182 | | 9 | 44 |
| | | Total proctocolectomy (TPC) | Lap 15 | 400 | TPC 7 | 8 | 57 |
| | | | Open 13 | 235 | | 9 | 67 |
| Athanasakis [2] | STC | Total colectomy with IRA | Lap 4 | 150–260 | 0 | 5.75 | 25 |
| Current series, 2003 | MUC/CD/STC/FAP | Total Colectomy with IRA | Lap 34 | 187 | 11.8 | 4.1 | 26.5 |
| | | | Open 34 | 126 | | 6.8 | 38.2 |

LOS, length of hospital stay; MUC, mucosal ulcerative colitis; FAP, familial adenomatous plyposis; STC, slow-transit constipation; IRA, ileorectal anastomosis; CD, Crohn's disease; TAC, total abdominal colectomy; TPC, total proctocolectomy

comparable with that for open procedures. Seshadri et al. [27] also compared the results of 37 laparoscopic and 36 OTC cases, but the series included only 12 patients who underwent total colectomy with ileorectal anastomosis in the laparoscopic group and 7 in the open group. Total colectomy with end ileostomy was performed in the remaining patients. Longer operating times but significantly shorter length of stays and fewer complications were reported for the laparoscopic group (Tables 2, 3).

The current case-matched comparative series included total colectomy and ileorectal or ileosigmoid anastomosis for patients with FAP, constipation, mucosal ulcerative colitis, and Crohn's colitis. Two surgeons (C.P.D., A.J.S.) performed all the laparoscopic procedures, and these were compared with a matched cohort of open colectomy procedures performed by an experienced team of colorectal surgeons. An advantage was seen with the laparoscopic procedure with respect to the LOS. Contrary to the findings reported by other authors [17, 21] a shorter LOS was noted with LTC in this series, the shortest reported in the literature and comparable with the short hospitalizations achieved with other laparoscopic segmental colectomy procedures [5, 10, 12, 13, 26]. Longer operative times were seen with LTC than with compared to OTC, but the time required was shorter than that reported by previous authors, and the operative times also were noted to drop with experience [1, 2, 21, 22] One of the arguments against laparoscopic total colectomy is that the procedure requires much longer operating times than laparoscopic segmental colectomy. We compared our mean operating times with that for a cohort of randomly selected laparoscopic proctosigmoidectomies and found that LTC took only 36 min longer.

In the absence of randomized controlled trials, carefully matched patient cohorts result in fairly similar groups of patients, while minimizing confounding factors. In this study, strict matching criteria were used to minimize selection bias, and the resulting statistical differences that arise as a result of a selection bias. The average BMI in the laparoscopic group was lower (24 vs 28), suggesting some bias attributable to the technical difficulty of laparoscopic total colectomy. Laparoscopic total colectomy is a more difficult procedure than laparoscopic segmental colectomy for the obese patient, total colectomy requires multiple quadrant dissection. Hence, at the authors' institution, total colectomy is not routinely offered as a first choice to patients with a BMI exceeding 27.

Although the complication rate was higher in the open group, there was no significant difference in the complication rates (26.5% vs 38.2%) between the two groups in our study. The higher complication rate of 38.2% in the open group arose because of complications such as postoperative ileus, and this rate mirrors the complication rate seen in the cohort of 153 open total colectomy patients (38.8%) from which these patients were selected. Furthermore, there was no significant difference in the complication rates between the two groups when patients with a BMI lower than 27 were analyzed. The complication rates seen in this series are comparable with those reported by other authors [2, 14, 17, 22, 27]. As compared with other laparoscopic colorectal procedures, there was no difference in the total costs because the shorter LOS tends to offset higher operating room costs.

## Conclusion

This large series of LTC cases with matched open cases demonstrates a significant decrease in LOS without any significant increase in complications, costs, or operating time over those associated with LPS. A laparoscopic approach to total colectomy and ileorectal anastomosis is recommended for suitable patients.

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