

## Comparative analysis of open and laparoscopic colectomy for malignancy in a developing country

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### Abstract

**AIM:** To compare the short-term, including oncologic, outcomes of open vs laparoscopic colectomy for cancer in a developing country.

**METHODS:** The records of patients who underwent elective open and laparoscopic colectomies for cancer at the University Hospital of the West Indies between January 2005 and December 2010 were retrospectively reviewed. Demographic (age, gender, Charlson comorbidity index score), peri-operative, post-operative and oncologic data were collected for each patient. Specific oncologic variables included lymph node yield, pathologic stage, grade, proximal, distal and circumferential margin involvement. Fisher's exact, Mann-Whitney, and binary logistic regression tests were used for analysis. Significance level was set at  $P < 0.05$ .

**RESULTS:** There were 87 cases for open colectomy

(OC) and 17 cases for laparoscopic colectomy (LC). Demographics did not significantly differ between OC and LC groups. Intra-operative blood loss and post-operative analgesic requirements did not significantly differ between groups. There was a trend towards longer operating times in OC group and shorter hospital stay in the LC group. Lymph node yield (14 vs 14,  $P = 0.619$ ), proximal (10 cm vs 7 cm,  $P = 0.353$ ) and distal (8 cm vs 8 cm,  $P = 0.57$ ) resection margin distance and circumferential margin involvement (9 vs 0,  $P = 0.348$ ) did not significantly differ between groups. Thirty-day morbidity was equivalent between groups (22 vs 6,  $P = 0.774$ ). There were 6 deaths within 30 d of initial procedure, all in the OC group (6.9%).

**CONCLUSION:** Laparoscopic colectomy in a developing country is oncologically safe and represents a option for colonic malignancies in these regions. Such data encourage the continued laparoscopic development.

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**Key words:** Laparoscopy; Colectomy; Cancer; Developing country; Colorectal; Oncology; Short-term; Outcomes

**Core tip:** The development of laparoscopic colectomy in developing countries has been slow despite strong evidence to support its benefit. The demonstration that laparoscopic procedures can be performed safely in these environments supports and encourages further incorporation of laparoscopy in these environments. Notwithstanding proven feasibility of laparoscopic colectomy for cancer in developing countries, there is the need to demonstrate equivalent oncologic outcomes to open surgery in order to establish safety. This study shows that laparoscopic colectomy for cancer in a developing country is not only feasible but is oncologically safe.

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## INTRODUCTION

Laparoscopic colectomy, first described in the early 1990s for diverticular disease, has become a viable option for the management of colorectal cancer. The first case of laparoscopic colonic resection for neoplasia was documented in 1991 following successful resection for a villous adenoma<sup>[1]</sup>. Subsequently, reports on the successful use of laparoscopic colectomy for cancer cases were increasingly published<sup>[2]</sup>.

Early concerns related to the oncologic equivalence to open colectomy (inadequacy of resection, staging inaccuracies and the possibility of the pneumoperitoneum affecting tumour dissemination) have been dispelled by randomized controlled trials (RCTs)<sup>[3-6]</sup> and meta-analyses<sup>[7]</sup>. These have demonstrated similar long-term oncologic outcomes compared to open colectomy, while also demonstrating superior short-term outcomes expected of the laparoscopic approach.

The incorporation of laparoscopic techniques in developing countries has been challenging, due in particular to the high costs of equipment and lack of expertise<sup>[8]</sup>. Despite these ongoing challenges, the continued use of laparoscopy is still encouraged<sup>[8]</sup>. Many laparoscopic procedures, including appendicectomy<sup>[9]</sup>, cholecystectomy<sup>[10,11]</sup> and hysterectomy<sup>[12]</sup>, splenectomy<sup>[13]</sup>, have successfully been performed in developing countries. A recent study from our institution demonstrated that laparoscopic colectomy for neoplasms is safe and feasible. Studies from other developing countries such as Argentina<sup>[14]</sup>, China<sup>[15,16]</sup>, Mexico<sup>[17]</sup> and Turkey<sup>[18]</sup>, have demonstrated the feasibility and safety of laparoscopic colectomy, but have neglected to demonstrate the equivalence to the open approach in these settings. Demonstrating oncologic outcomes similar to those achieved in a developed setting will further support the continued growth of laparoscopy for cancer in a developing country. There are currently limited data referencing the oncologic safety of laparoscopic colectomy in these settings. The present study provides further evidence regarding the oncologic safety of laparoscopic colectomy in a developing country. The primary aim of this study was to compare the short-term outcomes, particularly oncologic outcomes, of laparoscopic versus open colectomy for cancer.

## MATERIALS AND METHODS

### Ethics

This work has been carried out in accordance with the Second International Helsinki Declaration<sup>[19]</sup>. This study was ethically approved by the Faculty of Medical Sci-

ences/University of the West Indies Ethics Committee (File number: ECP 04, 13/14).

### Setting and operative approach

Surgical procedures were undertaken at a tertiary academic centre in a developing country. All surgeons were trained in Jamaica, while surgeons performing laparoscopic colectomy either had formal laparoscopic training or had undertaken mentorship programmes. The operative details have previously been published by Plummer *et al.*<sup>[20]</sup>. Briefly, the laparoscopic equipment included a standard laparoscopic tower, reusable trocars and reusable bowel graspers. Vascular control was achieved using clips or Ligasure® (when available) as opposed to stapling devices. Bowel mobilization and dissection was achieved using either monopolar cautery or ultrasonic shears (when available). With specific reference to right hemicolectomy, all patients had extracorporeal anastomoses following exteriorization of the colon.

### Data collection

This was a retrospective chart review of adult patients who underwent elective open or laparoscopic colectomy for cancer between January 1, 2005 and December 31, 2010 at the University Hospital of the West Indies. Emergency procedures and rectal resections were excluded. All included patients had preoperative colonoscopy with confirmation, by biopsy, of a carcinoma. Cases were grouped according to intention-to-treat: laparoscopic cases converted to open were included in the laparoscopic group. The decision to perform laparoscopic or open colectomies was based on the discretion of the attending surgeon. Demographic [age, gender, Charlson comorbidity index score (CCI)], peri-operative, post-operative and oncologic data were collected for each patient. Specific oncologic variables included lymph node yield, pathologic stage, grade, proximal, distal and circumferential margin involvement.

### Statistical analysis

Demographic, intra-operative, pathological, and post-operative variables between open colectomies (OC) and laparoscopic colectomies (LC) were analyzed using Fisher's exact (for categorical variables) and Mann-Whitney (for continuous variables). Logistic regression was used to determine if length of stay was significantly different between OC and LC group, controlling for all potential confounding variables. Significance level for all analyses was set at  $P < 0.05$ .

## RESULTS

Charts of one hundred and four patients were included. Of these, 87 persons underwent OC and 17 underwent LC. Neither gender, age, nor CCI significantly differed between OC and LC groups (Table 1).

Only one laparoscopic case was converted. Intra-operative blood loss did not differ significantly between

**Table 1** Demographics for open colectomy and laparoscopic colectomy for colonic carcinoma *n* (%)

		OC	LC	<i>P</i> value
Gender	Male	36 (41.4)	9 (52.9)	0.429
	Female	51 (58.6)	8 (47.1)	
Age [median, (5Q-75Q)], yr		66 (59-78)	62 (58-72)	0.363
Charlson score	0	7 (8.0)	1 (6.2)	0.501
	1	14 (16.1)	4 (25.0)	
	2	22 (25.3)	4 (25.0)	
	3	18 (20.7)	5 (31.2)	
	4	17 (19.5)	1 (6.2)	
	5	7 (8.0)	0 (0.0)	
	6	1 (1.1)	1 (6.2)	
	7	1 (1.1)	0 (0.0)	

OC: Open colectomy; LC: Laparoscopic colectomy.

**Table 2** Intra-operative outcomes for open colectomy and laparoscopic colectomy for colonic carcinoma *n* (%)

		OC	LC	<i>P</i> value
Procedure	RH	42 (48.3)	7 (41.2)	0.801
	Extended RH	9 (10.3)	1 (5.9)	
	LH	11 (12.6)	2 (11.8)	
	Extended LH	1 (1.1)	0 (0.0)	
	Transverse colectomy	1 (1.1)	0 (0.0)	
	Sigmoid colectomy	21 (24.1)	6 (35.3)	
	Total colectomy	2 (2.3)	1 (5.9)	
	Conversion	NA	1 (5.9)	
Total OR time (min)		165 (128-195)	195 (143-259)	0.075
[median (25Q-75Q)]				
Intraop blood loss (mL)		300 (200-600)	275 (188-550)	0.512
[median (25Q-75Q)]				

OC: Open colectomy; LC: Laparoscopic colectomy; RH: Right hemicolectomy; LH: Left hemicolectomy; NA: Not available.

groups (Table 2). Although there was not a significant difference in operating time between LC and OC, there was a trend towards longer operating times in the LC group ( $P = 0.075$ ; Table 2). This trend is further supported by the fact that 13 patients, all within the OC group, had another procedure along with their OC: cholecystectomy, liver biopsy, axillary dissection, small bowel resection, splenectomy, cystolithotomy, hysterectomy and oophorectomy. Contrarily, only 1 patient had a combined procedure (bilateral inguinal hernia repair) during LC.

There were no significant differences between OC and LC for any of the pathological outcomes (Table 3). These outcomes included lymph node yield ( $P = 0.619$ ), proximal ( $P = 0.353$ ) and distal ( $P = 0.57$ ) resection margin distance and circumferential margin involvement ( $P = 0.348$ ).

Controlling for potential confounders, there was a trend towards a shorter length of hospital stay in the LC group ( $P = 0.083$ ; Table 4). However, 30-d morbidity was equivalent between groups ( $P = 0.774$ ; Table 4). Complications included anastomotic leak, wound infection,

**Table 3** Pathological outcomes for open colectomy and laparoscopic colectomy for colonic carcinoma *n* (%)

		OC	LC	<i>P</i> value
Grade of differentiation	Well	9 (10.35)	4 (23.5)	0.166
	Moderate	74 (85.1)	10 (58.8)	
	Poor	4 (4.6)	0 (0.0)	
Proximal margin (cm)		10 (5-16)	7 (7-10)	0.353
[median (25Q-75Q)]				
Distal margin (cm)		8 (4-13)	8 (6-10)	0.570
[median (25Q-75Q)]				
CRM involved	Yes	9 (10.6)	0 (0.0)	0.348
	No	76 (89.4)	16 (100)	
LN yield [median (25Q-75Q)]		14 (10-17)	14 (10-15)	0.619

OC: Open colectomy; LC: Laparoscopic colectomy; CRM: Circumferential resection margin; LN: Lymph node.

**Table 4** Postoperative outcomes for open colectomy and laparoscopic colectomy for colonic carcinoma *n* (%)

		OC	LC	<i>P</i> value
30-d morbidity	No	46 (52.9)	8 (47.1)	0.774
	Yes	22 (25.3)	6 (35.3)	
	Not recorded	19 (21.8)	3 (17.6)	
30-d mortality	No	62 (71.3)	14 (82.4)	0.717
	Yes	6 (6.9)	0 (0.0)	
	Not recorded	19 (21.8)	3 (17.6)	
Parenteral narcotic doses [median (25Q-75Q)]		6 (4-9)	5 (4-7)	0.176
LOS (d) [median (25Q-75Q)]		6 (5-7)	5 (4-8)	

OC: Open colectomy; LC: Laparoscopic colectomy.

fascial dehiscence, prolonged ileus, respiratory failure, pulmonary embolus, left ventricular failure, and atelectasis. Anastomotic leakage occurred in 4 (3.8%) patients. The number of post-operative parenteral narcotic doses did not significantly differ between groups ( $P = 0.176$ ; Table 4). Despite 6 deaths in the OC group, a statistically significant difference in 30-d mortality was not demonstrated ( $P = 0.717$ ; Table 4).

## DISCUSSION

The present study demonstrates no statistical differences between open and laparoscopic colectomy with respect to short term oncologic outcomes (proximal, distal and circumferential margins and lymph node yield). This study represents the first comparative analysis of this nature from a developing country in the English-speaking Caribbean.

Numerous RCTs have demonstrated superior short-term outcomes in favour of laparoscopy with respect to post-operative pain, return of bowel function, length of hospitalization and cosmesis<sup>[3-6]</sup>. Furthermore, meta-analyses of multiple RCTs have concluded that laparoscopic colectomy for cancer provides superior short-term benefits and equivalent oncologic outcomes compared to

open colectomy<sup>[7]</sup>. More recent studies have even shown improved 30-day morbidity<sup>[7,21]</sup> and mortality<sup>[21-23]</sup> with laparoscopic colectomy, with some authors questioning whether it should be standard of care<sup>[24]</sup>.

Despite this evidence, open colectomy remains the most common approach to colonic resection in developing countries<sup>[8]</sup>. A previous study from our institution<sup>[20]</sup> demonstrated that laparoscopic colectomy could safely be performed for colonic neoplasia in a developing country. However, the study did not specifically evaluate peri-operative outcomes, including oncologic safety or compare such outcomes to a cohort of open cases. Lohsirawat *et al*<sup>[25]</sup> demonstrated equivalent short-term and oncologic outcomes in a retrospective series of patients undergoing open and laparoscopic right hemicolectomy for cancer in Thailand. Those results echo that of the present study where no statistically significant difference was found for positive margins or lymph node yield ( $P = 0.08$ ) between groups<sup>[25]</sup>.

Our results demonstrated a trend towards longer operative time and shorter length of hospital stay in the LC compared to the OC group. Although these findings are consistent with the literature<sup>[3-6]</sup>, our results are likely confounded by the inclusion of patients undergoing concomitant surgical procedures in the analysis. Thirteen of 14 cases with additional procedures occurred in the OC group. As such, this may have skewed results towards even longer operative times and hospital stay in the OC group. The equivalence seen between OC and LC groups regarding 30-d morbidity and mortality rates is consistent with previous literature<sup>[3-5]</sup>. Similarly, oncologic outcomes for OC and LC groups, including resection margins and lymph node yield are consistent with previous RCTs<sup>[3-6]</sup>.

This study has several limitations. Firstly, like all retrospective chart reviews, data abstraction may be affected by inconsistencies, and is limited to the information contained in patients' charts. Although nothing can be done to address the latter, the former limitation was addressed by having a second abstractor review 10% of patients' charts to ensure accuracy of the information collected. Secondly, although this study provides evidence supporting the safe use of LC in resource-restricted settings, contextual factors imperative for LC implementation, such as availability of equipment and cost, were not considered.

There was a significant difference in the numbers of OC *vs* LC cases. This is a limitation of the study, which will impact on the ability to make definitive conclusions. In addition, the disparity in numbers suggests persistent barriers to the incorporation of laparoscopy in our setting. A recent survey of surgeons in Jamaica suggested that cost and lack of expertise/training were the main barriers of laparoscopy uptake<sup>[26]</sup>. However, improved short-term outcomes such as shorter hospital stay, faster return to work, and reduced surgical site infection rates, often offset the upfront costs of laparoscopy<sup>[27]</sup>. In countries already performing laparoscopic cholecystectomy, no additional basic equipment is usually required for colectomy. Institutional investment in reusable bowel graspers

and needle drivers would obviate the need for disposables with some cost reduction. Some disposable equipment, however, have no reusable counterpart. As such, the initial cost of these disposables (including energy devices and staplers) to the institution or patient remains a challenge. Manoeuvres to avoid the need for these expensive devices, such as colonic mobilization with extracorporeal anastomoses, and the use of monopolar cautery and clips<sup>[13]</sup> have been described. Meta-analyses have failed to demonstrate any significant disadvantages to extracorporeal anastomoses for laparoscopic right sided colectomies<sup>[28]</sup>. Additionally, there is no evidence to suggest that use of energy devices is superior to monopolar cautery for laparoscopic colectomy<sup>[29]</sup>. The surgical technique employed in the present study utilized reusable instruments and extracorporeal anastomoses in order to reduce costs. Such techniques did not adversely affect outcomes. Future studies should incorporate these contextual factors when describing LC uptake in a resource-restricted setting.

Lack of expertise and training as a limiting factor for LC uptake underscores the need to incorporate LC in residency training<sup>[8,30]</sup>. The recent opening of a skills laboratory and the further addition of minimally invasive surgical staff to our institution have been methods instituted to address this issue. Unfortunately, these factors were not considered in this study and should be discussed in future work.

There remain many challenges to the use of laparoscopic colectomy for colonic carcinoma in developing countries. The equivalent short-term outcomes demonstrated between open and laparoscopic groups in the present study demonstrate that this is an oncologically safe approach in our environment. Continued strategies to reduce costs and increase surgeon training are essential to the further development of laparoscopic colectomy in developing countries. Only through these strategies can caseload increase allowing for progressive high-quality research in the field in these environments.

## COMMENTS

### Background

Laparoscopic colectomy for cancer has been proven to have superior short-term benefits to open colectomy with equivalent oncologic outcomes. These findings are based on large-scale studies conducted developed countries. The practice of laparoscopic colectomy in developing countries is limited. To date, few studies have sought to evaluate the benefit and oncologic safety of laparoscopic colectomy for patients in developing countries.

### Research frontiers

Laparoscopic surgery has revolutionized the care of patients worldwide, providing advantages of reduced pain, shorter hospital stay, earlier return to normal functioning and improved cosmesis. For developing countries, the research hotspot is the demonstration of similar outcomes as in developed countries, particularly for the use of laparoscopy in cancer cases.

### Innovations and breakthroughs

Previous studies on the use of laparoscopic colectomy in developing countries have demonstrated feasibility and safety. These studies are few as the practice of laparoscopic colectomy in these environments is limited, particularly by resource constraints. Very few studies have evaluated the specific effects of laparoscopy on oncologic outcomes of colon cancer in developing countries.



In the present study, authors compared a cohort of patients undergoing open and laparoscopic colectomy for cancer and found that the short-term oncologic outcomes were equivalent between the two groups.

## Applications

The study results suggest that laparoscopic colectomy for cancer can be safely performed, with equivalent short-term oncologic outcomes to open colectomy, in developing countries where resources may be limited.

## Terminology

Laparoscopy is a minimally invasive surgical technique where abdominal operations are undertaken through small incisions, thus minimizing bowel handling and causing less tissue trauma. Colectomy refers to the surgical excision of the colon or part thereof. Short-term oncologic outcomes related to colon cancer include proximal, distal and circumferential margin involvement and the numbers of lymph nodes harvested at the time of surgery.

## Peer review

The authors present a comparative study between open and laparoscopic approaches for colectomies in a developing country. They should be congratulated for addressing this relevant topic.

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