

# The adoption of laparoscopic colorectal surgery: a national survey of general surgeons

Husein Moloo, MD\*†  
 Fatima Hagggar, MPH\*‡  
 Guillaume Martel, MD\*†  
 Jeremy Grimshaw, MB, MCh,  
 PhD†‡  
 Doug Coyle, PhD†  
 Ian D. Graham, PhD†‡  
 Elham Sabri, MSc‡  
 Eric C. Poulin, MD\*  
 Joseph Mamazza, MD\*  
 Fady K. Balaa, MD\*  
 Robin P. Boushey, MD, PhD\*

From the \*Minimally Invasive Surgery Research Group, Division of General Surgery, and the ‡Clinical Epidemiology Unit, Ottawa Health Research Institute, and the †Department of Epidemiology and Community Medicine, The Ottawa Hospital and University of Ottawa, Ottawa, Ont.

The Minimally Invasive Surgery Research Group at the Ottawa Hospital is supported by unrestricted educational grants from Covidien Canada and Storz Canada. G. Martel is supported by a Fellowship Award in the area of knowledge translation from the Canadian Institutes of Health Research.

Accepted for publication  
 Sept. 3, 2008

## Correspondence to:

Dr. R.P. Boushey  
 The Ottawa Hospital — General Campus  
 501 Smyth Rd., CCW 1617  
 Ottawa ON K1H 8L6  
 fax 613 739-6646  
 rboushey@ottawahospital.on.ca

**Background:** Laparoscopic surgery may become the standard of care for the treatment of colorectal disease. Little is known regarding North American patterns of practice or the limiting factors and strategies for adoption among surgeons.

**Methods:** We sent a 28-item questionnaire to all general surgeon members of the Royal College of Physicians and Surgeons of Canada. We derived descriptive and correlative information using  $\chi^2$ , Wilcoxon rank sum and Student *t* tests and multivariate logistic regression.

**Results:** The return rate was 55% (694/1266). A total of 67% (462/694; 95% confidence interval 63%–70%) of respondents perform colorectal surgery. Of these, 54% perform laparoscopic colorectal surgery. Multivariate logistic regression identified 5 factors related to performing laparoscopic colorectal surgery: fewer years in practice ( $p < 0.001$ ), male sex ( $p = 0.015$ ), practising in the province of Quebec ( $p = 0.005$ ), university-hospital affiliation ( $p = 0.034$ ) and minimally invasive surgery fellowship training ( $p = 0.023$ ). Lack of adequate operating time and formal training were the main reasons cited by surgeons not offering laparoscopic colon resections. Most surgeons (67%) felt that site visits from a minimally invasive surgeon would represent the most effective training method for acquiring advanced laparoscopic skills.

**Conclusion:** About half of Canadian general surgeons offer laparoscopic colorectal resections. Recent graduation, male sex, practice location, university-hospital affiliation and minimally invasive surgery training are significant predictors for offering a laparoscopic approach. Lack of operative time and formal training are the main barriers to adoption of the technique. Site visits by trained laparoscopic surgeons is the preferred method of acquiring advanced skills.

**Contexte :** La chirurgie par laparoscopie est devenue la norme de soins pour le traitement des maladies colorectales. On ne connaît guère les tendances de la pratique en Amérique du Nord ou les facteurs limitateurs et les stratégies d'adoption chez les chirurgiens.

**Méthodes :** Nous avons envoyé un questionnaire en 28 points à tous les chirurgiens généraux membres du Collège royal des médecins et chirurgiens du Canada. Nous avons dérivé l'information descriptive et corrélative au moyen des tests  $\chi^2$ , de Wilcoxon et *t* de Student, ainsi que par régression logistique à variables multiples.

**Résultats :** Le taux de réponse s'est établi à 55 % (694/1266). Au total, 67 % (462/694; intervalle de confiance à 9 %, 63 % à 70 %) des répondants pratiquent la chirurgie colorectale. De ce nombre, 54 % pratiquent la chirurgie colorectale par laparoscopie. La régression logistique à variables multiples a dégagé 5 facteurs reliés à la chirurgie colorectale par laparoscopie : moins d'années de pratique ( $p < 0,001$ ), sexe masculin ( $p = 0,015$ ), pratique dans la province de Québec ( $p = 0,005$ ), affiliation à un hôpital universitaire ( $p = 0,034$ ) et fellowship en chirurgie à effraction minimale ( $p = 0,023$ ). Le manque de temps suffisant pour opérer et de formation structurée constituait la principale raison invoquée par les chirurgiens pour ne pas offrir la résection du côlon par laparoscopie. La plupart des chirurgiens (67 %) étaient d'avis que la méthode de formation la plus efficace pour leur permettre d'acquérir des techniques avancées de laparoscopie consistait en visites sur place d'un chirurgien pratiquant la chirurgie à effraction minimale.

**Conclusion :** Environ la moitié des chirurgiens généraux canadiens offrent la résection colorectale par laparoscopie. Le diplôme récent, le sexe masculin, le lieu de pratique, l'affiliation à un hôpital universitaire et une formation en chirurgie à effraction minimale sont des prédicteurs importants de l'approche laparoscopique. Le manque de temps pour opérer et de formation structurée constitue le principal obstacle à l'adoption de la technique. Des visites sur place par des chirurgiens formés en laparoscopie constituent la méthode préférée d'acquisition de techniques avancées.

Three main methods are currently used to perform a colorectal resection: the traditional “open” technique via a laparotomy, the laparoscopic approach and a hybrid hand-assisted laparoscopic approach using a device that allows the surgeon access through a minilaparotomy incision while maintaining the pneumoperitoneum. As more evidence from randomized trials demonstrating the efficacy and safety of the laparoscopic approach becomes available,<sup>1-7</sup> surgeons are increasingly pressured to offer minimally invasive procedures to patients with both benign and malignant colorectal pathology. Several advantages of laparoscopic colorectal surgery seem to drive patient and surgeon preference for this technique, including diminished incisional pain, a shorter period of postoperative ileus and reduced length of stay in hospital.<sup>8,9</sup>

Adoption rates among practising surgeons in Canada are perceived to remain low. A recent survey of community general surgeons in Ontario revealed that less than 5% of respondents performed a high volume of laparoscopic colorectal procedures (> 20/yr).<sup>10</sup> Surveys from the United States and the United Kingdom have reported variable adoption rates.<sup>11,12</sup> That being said, an increasing volume of publications indicate that this field is evolving rapidly, such that more Canadian surgeons have chosen to adopt this technology.<sup>13-15</sup> Canada-wide adoption rates, regional variations and factors determining the incorporation of laparoscopic colorectal surgery into practice have not been defined in the literature. As such, we designed the Minimally Invasive Surgical Trends in Canadian Colorectal Surgery survey to elicit the opinions of surgeons regarding the current status of laparoscopic colorectal surgery in Canada.

## METHODS

We developed a 28-item questionnaire to ascertain surgeons' personal and professional characteristics, details on the types and volume of laparoscopic colorectal procedures they perform, their views on the advantages and disadvantages of laparoscopic colorectal surgery and the most effective methods for acquisition of advanced minimally invasive surgery (MIS) skills. Translation Services at The Ottawa Hospital generated a French version ( $n = 205$ ), which a bilingual surgeon (E.C.P.) verified for proper surgical terminology. We piloted the survey with 8 general surgeons at The Ottawa Hospital before mailing. The Ottawa Hospital Research Ethics Board approved our study.

We identified all general surgeons in Canada who had a practice address registered with the Royal College of Physicians and Surgeons of Canada (RCPSC;  $n = 1266$ ). Surveys contained a unique mail identification code to ensure confidentiality. We used a modification of Dillman's Tailored Design Method to maximize the response rate.<sup>16</sup> Briefly, surgeons received an introductory letter about the study survey 2 weeks before the questionnaire; and a package containing a reminder letter, the question-

naire and a return-addressed, stamped envelope on day 14. We sent 2 additional mailings to nonrespondents on days 28 and 42. We discarded duplicate responses based on identification codes.

We digitally scanned completed surveys into a Microsoft Excel database using TELEform software (version 10.0) and exported the file into SPSS version 13.0 software (SPSS Inc.). To ensure data integrity, 3 individuals (H.M., F.H., E.S.) randomly audited 100 questionnaires and identified and verified extreme outliers and any other values that appeared inconsistent with the remainder of the data set.

We performed statistical analyses using SPSS. We used Pearson  $\chi^2$  tests and Student  $t$  tests to assess differences between groups in categorical and continuous variables, and Wilcoxon rank sum tests were used to compare median estimates. We performed univariate and multivariate logistic regression to identify predictive factors for performing laparoscopic resections. We considered results to be significant at  $p < 0.05$ . No adjustment was made for multiple testing.

## RESULTS

### *Demographic data of respondents*

Of the 1266 surveys mailed, 694 (55%) were returned. Forty-two (3%) surveys were ineligible (retirement, blank form, invalid address) and were excluded from analysis, thus yielding a response rate of 53% (652/1224). There was no statistically significant difference in response rates based on province, sex or language of correspondence (data not shown).

Most respondents were male surgeons (85%,  $n = 501$ ), were affiliated with a university teaching hospital (53%,  $n = 313$ ) and practised in Ontario (42%,  $n = 249$ ) or Quebec (20%,  $n = 122$ ). The age distribution of surgeons was widespread, but most were 40–50 years old (31%,  $n = 189$ ) and had been in practice for less than 10 years (37%,  $n = 223$ ). Most respondents performed colorectal surgery (433/652, 67%, 95% confidence interval [CI] 63%–70%). We further subclassified these surgeons into group 1 (those who performed laparoscopic colorectal surgery: 54%,  $n = 232$ ) and group 2 (those offering only open colorectal surgery: 46%,  $n = 201$ ).

The province with the highest proportion of surgeons performing laparoscopic colorectal surgery was Quebec (67%), followed by British Columbia (60%), Ontario (57%), Saskatchewan (54%), Alberta (45%), Manitoba (38%), Nova Scotia (36%), New Brunswick (22%) and Newfoundland and Labrador (10%). Complete demographic data can be seen in Table 1.

### *Surgeons performing laparoscopic colorectal surgery (group 1)*

Surgeons in group 1 were significantly younger (45.5 v. 49.8 yr,  $p = 0.002$ ), had fewer years in practice (14.0 v.

17.3 yr,  $p = 0.005$ ) and were more likely to practise in academic centres (60% v. 50%,  $p = 0.030$ ) than were group 2 surgeons (Table 2).

Respondents in group 1 reported a median number of 40 (interquartile range [IQR] 24–70) abdominal procedures during the previous 12 months, about 10 (IQR 4–20) of which were performed laparoscopically. Almost all (95%) of group 1 surgeons considered benign colorectal conditions to be appropriate indications for performing a laparoscopic resection. Additionally, 76% considered a laparoscopic resection of colorectal cancer with curative intent to be an appropriate indication; this number increased to 79% for palliation. The most commonly performed laparoscopic colorectal resections are listed in Table 3.

Most group 1 surgeons (81%) were aware of hand-assist devices for laparoscopic colorectal procedures; however, only 6% performed such procedures.

### Surgeons performing open colorectal surgery (group 2)

A small percentage of surgeons (6%) indicated that a

patient had refused surgery because they did not offer a laparoscopic resection. Most (94%) were aware that hand-assist devices were being used to perform laparoscopic colorectal surgery, although 73% did not feel the use of these devices would influence their decision to undertake laparoscopic colorectal surgery. The types of laparoscopic procedures performed most frequently by group 2 surgeons are shown in Figure 1. Most group 2 surgeons routinely performed laparoscopic cholecystectomy (99%) and appendectomy (73%), whereas laparoscopic ventral hernia (27%) and inguinal hernia (27%) repairs were performed much less frequently.

### Perceived barriers and facilitators to the adoption of laparoscopic colorectal surgery

A total of 47% of respondents in group 1 felt that surgeons are not appropriately reimbursed for laparoscopic colorectal surgery, compared with 24% in group 2 ( $p < 0.001$ ). Only 29% of surgeons in group 1 agreed that an increase would influence their decision to perform more laparoscopic resections. About 9% of surgeons in

**Table 1. Demographic characteristics of questionnaire respondents ( $n = 652$ )\***

Characteristic	Frequency (%)†
Sex	
Male	501 (85.2)
Female	87 (14.8)
Age, mean (SD) yr	49.2 (11.1)
< 40	164 (27.2)
40–50	189 (31.3)
51–60	143 (23.7)
> 60	107 (17.7)
Years in practice, median (IQR)	15.0 (18)
< 10	223 (37.0)
10–20	168 (27.9)
21–30	140 (23.3)
> 30	71 (11.8)
Province	
Alberta	55 (9.2)
British Columbia	66 (11.0)
Manitoba	30 (5.0)
New Brunswick	19 (3.2)
Newfoundland and Labrador	13 (2.2)
Nova Scotia	19 (3.2)
Ontario	249 (41.5)
Prince Edward Island	5 (0.8)
Quebec	122 (20.3)
Saskatchewan	21 (3.5)
Hospital affiliation	
University (with residents)	313 (53.1)
University (without residents)	49 (8.3)
Nonuniversity (with residents)	66 (11.2)
Nonuniversity (without residents)	161 (27.3)

IQR = interquartile range; SD = standard deviation.  
\*Where data are missing, categories do not add up to 100%.  
†Unless otherwise indicated.

**Table 2. Demographic characteristics of surgeons performing open versus laparoscopic colorectal surgery ( $n = 433$ )\***

Characteristic	Group; frequency (%)†		$p$ value
	Laparoscopic colectomy, $n = 232$	Open colectomy, $n = 211$	
Age, mean (SD) yr	45.5 (8.9)	49.8 (10.9)	< 0.001
Sex			0.09
Male	182 (54.5)	152 (55.5)	
Female	27 (42.9)	36 (47.1)	
Years in practice, median (IQR)	12.5 (6–21)	16.0 (7–27)	0.005
Hospital affiliation			0.55
University	129 (57.3)	96 (42.7)	
Nonuniversity	87 (47.8)	95 (52.2)	
Region			< 0.001
Central Canada	151 (60.2)	100 (39.8)	
Prairie provinces	28 (44.4)	35 (55.6)	
West coast	29 (60.4)	19 (39.6)	
Atlantic provinces	10 (21.3)	37 (78.7)	

IQR = interquartile range; SD = standard deviation.  
\*Where data are missing, categories do not add up to 100%.  
†Unless otherwise indicated.

**Table 3. Types of bowel procedures performed laparoscopically**

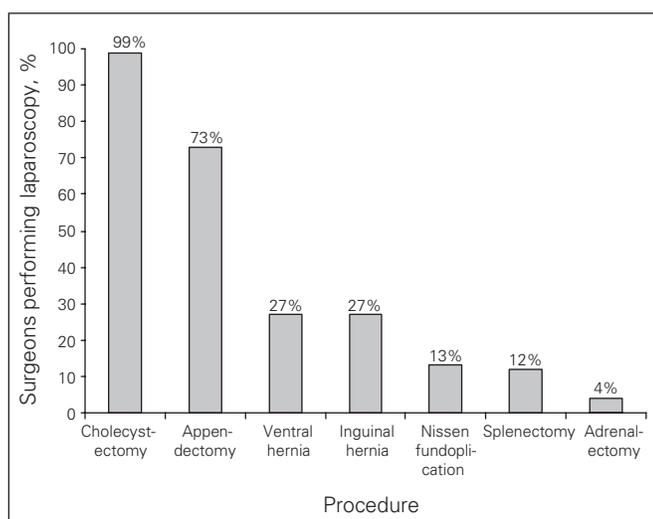
Procedure	Frequency (%)
Right hemicolectomy	201 (86.6)
Sigmoid colectomy	181 (78.0)
Left hemicolectomy	157 (67.7)
Stoma creation	150 (64.7)
Anterior resection of the rectum	113 (48.7)
Low anterior resection of the rectum	81 (34.9)
Subtotal colectomy	77 (33.2)
Abdominoperineal resection	56 (24.1)
Rectopexy	51 (22.0)

group 2 agreed that an increase in reimbursement would influence their decision to learn laparoscopic procedures.

In group 1, more surgeons “agreed” or “strongly agreed” that a lack of available operating time (55%) and patient factors (55%) influenced their decision to offer a laparoscopic approach compared with 1) not having adequate laparoscopic facilities at their institutions (25%,  $p < 0.001$ ), 2) already being satisfied with the number of laparoscopic colorectal procedures being performed at their institutions (34%,  $p = 0.006$ ), 3) not being comfortable operating without tactile sensation (23%,  $p < 0.001$ ) and 4) awaiting further evidence from clinical trials (13%,  $p < 0.001$ ; Table 4).

In group 2, surgeons felt that a lack of formal training (51% “agreed” or “strongly agreed”) and inadequate operating time (57%) were the main reasons for not performing laparoscopic colorectal surgery compared with all other reasons combined (27%,  $p < 0.001$ ; Table 5). Importantly, surgeons in group 2 were less comfortable with operating without tactile sensation compared with surgeons in group 1 (63% v. 44%,  $p = 0.008$ ).

Most respondents in group 1 (67%) and group 2 (68%)



**Fig. 1.** Percentage of group 2 surgeons (open colorectal surgeons) performing laparoscopy, by procedure category.

“strongly agreed” or “agreed” that a visit from an MIS-trained surgeon was their preferred method for acquiring advanced MIS skills (Table 6). Fellowships were rated the least desirable among the different types of training methods.

### Identification of factors associated with offering laparoscopic surgery

After univariate analysis comparing demographic factors among those offering laparoscopic surgery, we selected variables with a  $p \leq 0.15$  for multivariate analysis using stepwise logistic regression. In addition, we found surgeon age to be highly correlated with years of surgical experience ( $r = 0.941$ ,  $p < 0.001$ ). As such, we excluded this variable, as the number of years of experience was thought to be more clinically relevant. There was no statistical correlation between MIS training and the province of practice.

On multivariate analysis, geographical location in Quebec (odds ratio [OR] 5.40, 95% CI 1.67–17.48,  $p = 0.005$ ), male sex (OR 2.28, 95% CI 1.18–4.43,  $p = 0.015$ ), MIS subspecialty training (OR 2.12, 95% CI 1.11–4.06,  $p = 0.023$ ) and university hospital affiliation (OR 1.65, 95% CI 1.04–2.62,  $p = 0.034$ ) were all independent significant predictors for offering laparoscopic colorectal surgery (group 1; Table 7). Moreover, the number of years of surgical experience was strongly inversely predictive of offering laparoscopic colorectal surgery (OR 0.94, 95% CI 0.92–0.97,  $p < 0.001$ ). We detected no interaction effects between any of the significant factors.

### DISCUSSION

About half of general surgeons performing colorectal surgery in Canada offer a laparoscopic approach for both benign and malignant conditions. Fellowship training in MIS, male sex, having fewer years of surgical experience, university hospital affiliation and practising in Quebec were factors found to be significantly predictive of performing laparoscopic colorectal surgery. Lack of formal training and inadequate operating time were the main obstacles identified by surgeons not offering this approach.

Attitude	Level of agreement; no. (%)		
	Strongly disagree or disagree	Neutral	Strongly agree or agree
I do not have enough operating time to always offer a laparoscopic approach.	69 (30.1)	34 (14.9)	125 (54.8)
I am satisfied with the number of laparoscopic colorectal procedures being performed at my institution.	97 (42.1)	55 (23.9)	78 (34.0)
I do not have adequate laparoscopic facilities at my institution.	133 (59.4)	34 (15.2)	57 (25.5)
I am awaiting the results from further prospective randomized clinical trials demonstrating the effectiveness of the procedure before performing laparoscopic procedures for malignancy.	163 (72.8)	32 (14.3)	29 (13.0)
Patient factors (i.e., body habitus, multiple previous surgeries) are the main determinant of whether I proceed with a laparoscopic approach.	60 (26.2)	43 (18.8)	126 (55.0)
I am not comfortable operating without tactile sensation (i.e., inability to palpate tumour, blood vessels) in certain cases).	143 (62.7)	32 (14.0)	53 (23.3)

A visit from a trained MIS surgeon appears to be the preferred method to acquire advanced laparoscopic skills among both groups.

Several limitations of our study should be considered. First, even with an acceptable response rate such as ours, it is possible that proponents of MIS would be more likely to respond to a survey of this type, thus introducing a potential source of response bias. Second, the 1266 participants included only surgeons who had a practice address listed with the RCPSC. An additional 600 surgeons could not be included in the study on the basis of this methodological limitation. In addition, surgeons who may have only recently entered the profession were not included in the RCPSC mailing list. With the finding of recent graduation being a predictive factor, this limitation may have in fact have minimized any potential age bias, as the percentage of surgeons in group 1 would have presumably increased. Finally, overestimations of case volume likely occurred owing to recall bias.

The strengths of our study lie in the satisfactory response rate, yielding a large sample size. This sample

appears to be representative of the Canadian surgical community. In addition, it appears that this sample population of surgeons was surveyed with minimal response bias, as evidenced by our comparison of demographic factors. Our use of a multivariate statistical model strengthens our ability to identify factors predictive of offering laparoscopic colorectal surgery.

A recent survey of community general surgeons in Ontario found that fewer than 5% of respondents performed a high volume of laparoscopic colorectal surgery.<sup>10</sup> This report was limited by its focus upon community surgeons from a single province. Another cross-sectional study from the United States demonstrated that 48% of members of the American Society of Colon and Rectal Surgeons and the Society of American Gastrointestinal Endoscopic Surgeons performed laparoscopic resections for colorectal diseases.<sup>11</sup> A notable discrepancy between our study and the American survey is the difference between rates of colon cancer procedures carried out for curative reasons. Mavrantonis and colleagues<sup>11</sup> reported that only 15% of respondents performed laparoscopic colon cancer

**Table 5. Group 2 surgeons' ratings on potential barriers to performing laparoscopic colorectal surgery**

Attitude	Level of agreement; no. (%)		
	Strongly disagree or disagree	Neutral	Strongly agree or agree
I did not obtain enough formal training in laparoscopic surgery.	51 (26.7)	42 (22.0)	98 (51.3)
There is inadequate financial reimbursement for laparoscopic colorectal resections.	55 (29.0)	73 (38.4)	62 (32.6)
I do not have time to spend learning advanced laparoscopic techniques.	66 (34.6)	42 (22.0)	83 (43.4)
I do not have adequate operating time to offer laparoscopic colorectal resections to my patients.	46 (24.7)	34 (17.9)	109 (57.3)
I do not like to operate without tactile sensation (i.e., inability to palpate tumour, blood vessels).	83 (43.7)	59 (31.1)	48 (25.2)
I do not have adequate laparoscopic facilities at my institution.	97 (51.6)	25 (13.3)	66 (35.1)
I have medico-legal concerns with laparoscopic colorectal resections.	123 (64.4)	53 (27.7)	15 (7.8)
I am awaiting further evidence from prospective randomized clinical trials about its effectiveness before performing laparoscopic procedures for malignancy.	79 (41.8)	52 (27.5)	58 (30.7)
Laparoscopic surgery does not offer any advantage over traditional open techniques.	99 (51.8)	61 (31.9)	31 (16.2)

**Table 6. Respondents' ratings on their preferred methods for the acquisition of advanced MIS skills**

Training method	Group, level of agreement; no. (%)						Total median	p value*
	Group 1			Group 2				
	Strongly disagree or disagree	Neutral	Strongly agree or agree	Strongly disagree or disagree	Neutral	Strongly agree or agree		
Weekend courses (didactic, laboratory format)	52 (24.1)	53 (24.7)	110 (51.2)	46 (25.4)	29 (16.0)	106 (58.6)	4	0.30
Week-long courses (didactic and laboratory format with preceptorship or proctoring on laparoscopic bowel resections)	41 (18.8)	52 (23.9)	125 (57.3)	28 (15.1)	33 (17.7)	12 (67.2)	4	0.12
Trained MIS surgeon outreach (1–2 wk visits involving facility assessments and instruction or assistance with laparoscopic cases)	24 (10.4)	50 (22.6)	147 (66.5)	23 (12.4)	37 (19.9)	126 (67.8)	4	0.38
Mini-sabbaticals/proctorship (1–6 mo off practice to work as a trainee at an MIS training centre)	85 (39.0)	34 (15.6)	99 (45.4)	78 (41.7)	31 (16.6)	78 (41.7)	3	0.28
Fellowship (1 yr dedicated to MIS training)	118 (56.2)	30 (14.3)	62 (29.5)	121 (65.8)	26 (14.1)	37 (20.1)	2	0.023
Telementoring (purchase of equipment that would allow live broadcasting of mentor performing laparoscopic cases)	78 (36.1)	73 (33.8)	65 (30.1)	76 (41.1)	51 (27.6)	58 (31.4)	3	0.87

MIS = minimally invasive surgery.

\*Refers to comparison across groups using the  $\chi^2$  test.

surgery for curative purposes, whereas our respondents reported a much higher rate of 76%. One possible explanation for this difference could be that the American study was completed before the release of results from large prospective trials.<sup>3,5,6</sup> It is likely that these studies have had a major impact on surgical practice. The proportion obtained in the current survey is comparable to that in a 2005 study of the Association of Coloproctology of Great Britain and Ireland that reported that 78% of surgeons who performed laparoscopic resection did so for benign and malignant conditions.<sup>12</sup>

The present study is among the first to derive correlative information and limiting factors to the performance of laparoscopic colorectal procedures. One such predictor was that younger surgeons were more likely to offer laparoscopic resection. If we combine this finding with the fact that a surgeon in an academic centre is more likely to offer laparoscopy, then one could deduce that many of the surgeons trained in recent years are feeling comfortable with laparoscopic colorectal resections. This observation could be related to increased exposure to laparoscopy in residency training programs. Many authors have argued that colonic resections are technically more challenging than other laparoscopic procedures.<sup>17,18</sup> As such, one could reason

that the degree of supervision available during residency training may be principally important, particularly when compared with the rapid adoption of laparoscopic cholecystectomy following limited training in the early 1990s.<sup>19</sup> Nevertheless, only 18% of general surgery residents in Canada believed that their training in advanced laparoscopy in 2003 would be adequate at graduation, and most were concerned about their ability to acquire these skills once in practice.<sup>20</sup>

Fellowship training for individuals interested in acquiring advanced laparoscopic skills thus becomes necessary,<sup>21</sup> and it is not surprising to find that it was a predictor for performing laparoscopic resections. The number of surgeons pursuing fellowship training may have been underestimated as a result of fewer recent graduates having a practice address registered with the RCPSC. The number of fellowship programs and positions has increased dramatically over the past 5 years, which highlights the importance of this technology to new general surgeons. Interestingly, colorectal fellowship training was not a predictive factor of performing a laparoscopic resection on multivariable analysis.

Provincial variations are significant in this study. Surgeons in Ontario, Quebec and British Columbia were more likely

**Table 7. Identification of factors associated with performing laparoscopic colorectal surgery**

Factor	No. (%)		Univariate analysis		Multivariate analysis	
	Total	LC	OR (95% CI)	p value	OR (95% CI)	p value
Sex						
Male	330	183 (55.5)	1.66 (0.96–2.86)	0.07	2.28 (1.18–4.43)	0.015
Female	630†	27 (42.9)	1.00	—	1.00	—
Colorectal subspecialty training	65					
Training v. no training		45 (69.2)	2.09 (1.19–3.69)	0.010	1.75 (0.87–3.53)	0.12
MIS subspecialty training	69					
Training v. no training		49 (71.0)	2.33 (1.33–4.08)	0.003	2.12 (1.11–4.06)	0.023
Province*				< 0.001		
Alberta	31	14 (45.2)	1.34 (0.43–4.14)	0.61	1.36 (0.36–5.09)	0.65
British Columbia	48	29 (60.4)	2.48 (0.87–7.11)	0.09	3.39 (0.99–11.63)	0.05
Manitoba	21†	8 (38.1)	1.00	—	1.00	—
New Brunswick	18	4 (22.2)	0.46 (0.11–1.92)	0.29	0.60 (0.13–2.88)	0.53
Newfoundland and Labrador	10	1 (10.0)	0.18 (0.019–1.71)	0.14	0.19 (0.017–2.17)	0.18
Nova Scotia	14	5 (35.7)	0.90 (0.22–3.68)	0.89	1.28 (0.26–6.24)	0.76
Ontario	164	93 (56.7)	2.13 (0.84–5.41)	0.11	2.79 (0.92–8.46)	0.07
Quebec	87	58 (66.7)	3.31 (1.23–8.87)	0.018	5.40 (1.67–17.48)	0.005
Saskatchewan	11	6 (54.5)	1.95 (0.45–8.55)	0.38	2.77 (0.50–15.32)	0.24
Years in practice				0.002	0.94 (0.92–0.97)	< 0.001
Age, yr				< 0.001		
< 40	129	83 (63.9)	3.82 (1.94–7.54)	< 0.001		
40–50	126	71 (55.9)	2.73 (1.39–5.37)	0.004		
51–60	100	49 (48.5)	2.03 (1.01–4.09)	0.046		
> 60	53†	17 (30.9)	1.00	—		
Hospital affiliation						
University	226	130 (57.5)	1.39 (0.93–2.06)	0.11	1.65 (1.04–2.62)	0.034
Nonuniversity	176†	87 (49.4)	1.00	—	1.00	—

CI = confidence interval; LC = laparoscopic colectomy; MIS = minimally invasive surgery; OR = odds ratio.  
 \*Prince Edward Island (5 surgeons) and Northwest Territories (1 surgeon) excluded from logistic regression owing to small numbers.  
 †Indicates reference group.

to report undertaking laparoscopic colorectal resections compared with those in other provinces. These are also the 3 most populous provinces. The fact that a greater proportion of surgeons in these 3 provinces perform laparoscopic resections may be due to a greater ease of access to training facilities, as all 3 provinces have numerous academic centres and community hospitals that act as training facilities. The proportion of surgeons in Atlantic provinces (Nova Scotia, New Brunswick and Newfoundland and Labrador) performing laparoscopic colorectal resections was below the national average. It is possible that a "critical mass" of surgeons in a region is necessary before a novel procedure gains acceptance and becomes adopted. As such, less populous areas may lack this support. A follow-up survey of surgeons practising in Atlantic provinces may be useful in identifying reasons for the lack of widespread adoption of laparoscopic colorectal surgery, as well as possible change in time.

One of the predictive factors identified for performing laparoscopic resections was male sex. The reason for this is unclear, but may be related to variations in type of practice or other intangible factors such as exposure to video games.<sup>22</sup>

Operative time and lack of formal training appear to be the main barriers to offering more laparoscopic procedures or learning to perform laparoscopic colorectal surgery. Birch and colleagues<sup>10</sup> have identified similar barriers in their survey of Ontario community surgeons. When considering the 2 main obstacles, operating time does not appear to be something that will increase significantly within the current health care environment in Canada. Therefore, the obstacle that can be more easily addressed concerns skill acquisition. Advocates of hand-assisted laparoscopic surgery suggest that this technology can reduce operative time and may be more suitable for surgeons already in practice.<sup>23</sup>

Whereas fellowships in advanced laparoscopy may become increasingly valuable for junior trainees, we found that the most commonly preferred method of skill acquisition was in fact the visit of an expert MIS surgeon to the centre where the surgeon practices and the proctorship of cases within that setting. One of the keys to being able to perform a laparoscopic colon resection is having the appropriate equipment available. It is also important that operating room staff, from scrub nurse to anesthesiologist, be familiar with advanced laparoscopic techniques. A visit by an experienced surgeon (possibly with a nurse or anesthesiologist) has the potential to deal with these logistical issues. Evidence exists in the literature to suggest that targeted mentorship of advanced laparoscopy can be successful.<sup>13</sup> The perceived need for visits by expert MIS surgeons raises several issues regarding the funding of such activities. In the Canadian context, we believe that such activities would be best supported by provincial ministries of health and local health networks, with the goal of standardizing the delivery of advanced surgical care within health regions.

Nevertheless, our results suggest that even among those already offering laparoscopic colorectal surgery, laparoscopic abdominal surgeries account for a median of about 10 procedures yearly. This finding is troubling and raises important concerns regarding the delivery of advanced laparoscopic surgical care. Indeed, our data seem to indicate that a large proportion of general surgeons perform less than 1 case of laparoscopic colorectal surgery per month. Even with advanced laparoscopic surgery training, it is likely that this case-volume relation is too small to maintain proficiency. For those surgeons who learned laparoscopy through various weekend courses, it is unlikely that this operative volume would allow ascension along the learning curve. Further work is needed to evaluate actual case volumes in Canada, as our survey did not expressly address this question. In the meantime, we believe that surgeons must make every effort to practise safe laparoscopic colorectal surgery. Surgeons should seek sufficient training to carry out advanced laparoscopic colorectal surgery, particularly in the context of malignant pathologies. Careful patient selection,<sup>24</sup> particularly in the earliest portion of the learning curve, represents another useful strategy. We further advocate careful review of one's outcomes through the use of prospective databases and the entry of patients into multicentre trials.

With increased operative time for a laparoscopic resection, fewer procedures can be performed. In an environment where procedures will be cancelled owing to time constraints, financial reimbursement is an important aspect to examine. Only 8% of surgeons in the open group stated that they would consider learning how to do laparoscopic resections if financial reimbursement increased. Based on the survey results, even though many surgeons do not consider the current fee schedule to be sufficient, it does not appear to affect the type of procedure offered to the patient.

In disseminating laparoscopic colorectal surgery, hand-assist devices are increasingly being used in the United States.<sup>23</sup> In Canada, these devices have had a very low uptake. Surgeons in both groups demonstrated little interest in learning more about this technique. The reason for this finding is unclear, but may be related to limited awareness or concerns regarding the cost of these devices in the context of a publicly-funded health care system. Few data exist regarding the cost of hand-assist devices, but one could speculate that Canadian general surgeons do not perceive these devices to be cost-effective.

There are still a number of unanswered questions regarding laparoscopy in colorectal surgery in Canada. One such question pertains to the most efficient method for practising surgeons to acquire advanced laparoscopic skills. In light of the fact that not all graduating residents feel comfortable performing advanced laparoscopic procedures,<sup>20</sup> this issue may become important enough to make the hiring of laparoscopic surgeons in academic centres a priority.<sup>25</sup>

## CONCLUSION

A large percentage of general surgeons are offering laparoscopic colorectal resections. Recent graduation, male sex, practise in Quebec, university-hospital affiliation and formal MIS training appear to be significant independent predictors for offering a laparoscopic approach. Lack of operative time and formal MIS training are the main barriers to adopting this approach. Hospital visits by a trained laparoscopic surgeon was identified by both groups as the preferred method of acquiring the skills necessary to perform these procedures.

**Competing interests:** Dr. Mamazza received unrestricted educational grants from Covidien and Karl Storz Endoscopy. None declared for all other authors.

**Contributors:** Drs. Moloo, Grimshaw, Coyle, Graham, Poulin, Mamazza, Balaa and Boushey designed the study. Drs. Moloo, Martel and Balaa and Ms. Hagggar acquired the data. Drs. Moloo, Martel, Grimshaw, Coyle, Graham, Poulin, Mamazza and Boushey and Ms. Hagggar and Ms. Sabri analyzed the data. Drs. Moloo, Martel and Boushey and Ms. Hagggar wrote the article. All authors reviewed the article and approved its publication.

## References

- Lacy AM, García-Valdecasas JC, Delgado S, et al. Laparoscopy-assisted colectomy versus open colectomy for treatment of non-metastatic colon cancer: a randomised trial. *Lancet* 2002;359:2224-9.
- Lacy AM, Delgado S, Castells A, et al. The long-term results of a randomized clinical trial of laparoscopy-assisted versus open surgery for colon cancer. *Ann Surg* 2008;248:1-7.
- The Clinical Outcomes of Surgical Therapy Study Group. A comparison of laparoscopically assisted and open colectomy for colon cancer. *N Engl J Med* 2004;350:2050-9.
- Fleshman J, Sargent DJ, Green E, et al. Laparoscopic colectomy for cancer is not inferior to open surgery based on 5-year data from the COST Study Group trial. *Ann Surg* 2007;246:655-62.
- Veldkamp R, Kuhry E, Hop WC, et al. Laparoscopic surgery versus open surgery for colon cancer: short-term outcomes of a randomised trial. *Lancet Oncol* 2005;6:477-84.
- Guillou PJ, Quirke P, Thorpe H, et al. Short-term endpoints of conventional versus laparoscopic-assisted surgery in patients with colorectal cancer (MRC CLASICC trial): multicentre, randomized controlled trial. *Lancet* 2005;365:1718-26.
- Jayne DG, Guillou PJ, Thorpe H, et al. Randomized trial of laparoscopic-assisted resection of colorectal carcinoma: 3-year results of the UK MRC CLASICC trial group. *J Clin Oncol* 2007;25:3061-8.
- Young-Fadok TM. Minimally invasive techniques for colorectal cancer. *Surg Oncol* 1998;7:165-73.
- Schwenk W, Böhm B, Müller JM. Postoperative pain and fatigue after laparoscopic or conventional colorectal resections: a prospective randomized trial. *Surg Endosc* 1998;12:1131-6.
- Birch DW, Misra M, Farrokhyar F. The feasibility of introducing advanced minimally invasive surgery into surgical practice. *Can J Surg* 2007;50:256-60.
- Mavrantonis C, Wexner SD, Nogueras JJ, et al. Current attitudes in laparoscopic colorectal surgery. *Surg Endosc* 2002;16:1152-7.
- Harinath G, Shah PR, Haray PN, et al. Laparoscopic colorectal surgery in Great Britain and Ireland — Where are we now? *Colorectal Dis* 2005;7:86-9.
- Birch DW, Asiri AH, de Gara CJ. The impact of a formal mentoring program for minimally invasive surgery on surgeon practice and patient outcomes. *Am J Surg* 2007;193:589-91.
- Sebajang H, Hegge S, McKinley C. Can community surgeons perform laparoscopic colorectal surgery with outcomes similar to tertiary care centres? *Can J Surg* 2007;50:110-4.
- Do LV, Laplante R, Miller S, et al. Laparoscopic colon surgery performed safely by general surgeons in a community hospital: a review of 154 consecutive cases. *Surg Endosc* 2005;19:1533-7.
- Dillman DA. *Mail and internet surveys: the tailored design method*. New York (NY): Wiley; 2000.
- Schlachta CM, Mamazza J, Seshadri PA, et al. Defining a learning curve for laparoscopic colorectal resections. *Dis Colon Rectum* 2001;44:217-22.
- Reichenbach DJ, Tackett AD, Harris J, et al. Laparoscopic colon resection early in the learning curve: What is the appropriate setting? *Ann Surg* 2006;243:730-7.
- Morino M, Festa V, Garrone C. Survey on Torino courses: the impact of a two-day practical course on apprenticeship and diffusion of laparoscopic cholecystectomy in Italy. *Surg Endosc* 1995;9:46-8.
- Chiasson PM, Pace DE, Schlachta CM, et al. Minimally invasive surgery training in Canada: a survey of general surgery. *Surg Endosc* 2003;17:371-7.
- Balaa F, Moloo H, Poulin EC, et al. Broad-based fellowships: a cornerstone of minimally invasive surgery education and dissemination. *Surg Innov* 2007;14:205-10.
- Rosser JC Jr, Lynch PJ, Cuddihy L, et al. The impact of video games on training surgeons in the 21<sup>st</sup> century. *Arch Surg* 2007;142:181-6.
- Marcello PW, Fleshman JW, Milsom JW, et al. Hand-assisted laparoscopic vs. laparoscopic colorectal surgery: a multicenter, prospective, randomized trial. *Dis Colon Rectum* 2008;51:818-26.
- Bouchard A, Martel G, Sabri E, et al. Does experience with laparoscopic colorectal surgery influence intraoperative outcomes? *Surg Endosc* 2009;23:862-8.
- Martel G, Poulin EC, Mamazza J, et al. Laparoscopy influences hiring practices within academic surgical departments. *Surg Endosc* 2009;23:341-6.