Retrospective review of rectal cancer surgery in northern Alberta

Jean-Sébastien Pelletier, MD*
Christopher DeGara, MD*
Geoff Porter, MD, MSc†
Sunita Ghosh, MSc‡
Dan Schiller, MD, MSc*

From the *Department of Surgery, University of Alberta, Edmonton, Alta., the †Departments of Surgery and Community Health and Epidemiology, Dalhousie University, Halifax, NS, and ‡Medical Oncology, the Cross Cancer Institute, Edmonton, Alta.

Accepted for publication
Oct. 2, 2012

Correspondence to:
J.-S. Pelletier
2D2.08 WMC
8440 112 St.
Edmonton AB T6G 2B7
pelletie@ualberta.ca

DOI: 10.1503/cjs.006612

Introduction: Previous studies, including research published more than 10 years ago in Northern Alberta, have demonstrated improved outcomes with increased surgical volume and subspecialisation in the treatment of rectal cancer. We sought to examine contemporary rectal cancer care in the same region to determine whether practice patterns have changed and whether outcomes have improved.

Methods: We reviewed the charts of all patients with rectal adenocarcinoma diagnosed between 1998 and 2003 who had a potentially curative resection. The main outcomes examined were 5-year local recurrence (LR) and disease-specific survival (DSS). Surgeons were classified into 3 groups according to training and volume, and we compared outcome measures among them. We also compared our results to those of the previous study from our region.

Results: We included 433 cases in the study. Subspecialty-trained colorectal surgeons performed 35% of all surgeries in our study compared to 16% in the previous study. The overall 5-year LR rate and DSS in our study were improved compared to the previous study. On multivariate analysis, the only factor associated with increased 5-year LR was presence of obstruction, and the factors associated with decreased 5-year DSS were high-volume noncolorectal surgeons, presence of obstruction and increased stage.

Conclusion: Over the past 10 years, the long-term outcomes of treatment for rectal cancer have improved. We found that surgical subspecialization was associated with improved DSS but not LR. Increased surgical volume was not associated with LR or DSS.

Contexte : Des études antérieures, y compris des recherches menées dans le nord de l'Alberta et publiées il y a plus de 10 ans, ont montré une amélioration des résultats associée à un volume chirurgical accru et à la surspécialisation dans le traitement du cancer rectal. Nous avons voulu constater le traitement actuel du cancer rectal dans cette même région pour déterminer si les modes de pratique ont évolué et si les résultats se sont améliorés.

Méthodes : Nous avons passé en revue les dossiers de tous les patients porteurs d'un adénocarcinome du rectum diagnostiqué entre 1998 et 2003 qui ont subi une résection à visée curative. Les principaux paramètres analysés ont été la récurrence locale (RL) et la survie spécifique à la maladie (SSM) à 5 ans. Nous avons réparti les chirurgiens en 3 groupes selon leur formation et leur volume d'interventions et nous avons comparé les résultats entre eux. Nous avons aussi comparé nos résultats à ceux de l'étude précédente réalisée dans notre région.

Résultats : Nous avons inclus 433 cas dans l'étude. Les chirurgiens spécialisés en intervention colorectale ont effectué 35 % de toutes les chirurgies de notre étude, contre 16 % lors de l'étude précédente. Dans notre étude, les taux globaux de RL et de SSM à 5 ans se sont améliorés comparativement aux résultats de l'étude précédente. À l'analyse multivariée, le seul facteur associé à une augmentation des RL à 5 ans a été la présence d'obstruction et les facteurs associés à une diminution de la SSM à 5 ans ont été le fort volume des interventions par des chirurgiens non spécialisés en chirurgie colorectale, la présence d'obstruction et le stade plus avancé du cancer.

Conclusion : Au cours des 10 dernières années, les résultats à long terme du traitement du cancer rectal se sont améliorés. Nous avons constaté qu'une surspécialisation chirurgicale était associée à une amélioration de la SSM, mais non de la RL. L'augmentation du volume de chirurgies n'a pas eu d'incidence sur la RL ou la SSM.

In spite of recent advances in treatment, rectal cancer remains one of the most important causes of cancer-related morbidity and mortality in the Western world. While radiation and chemotherapy play important roles in the multidisciplinary treatment of rectal cancer, meticulous surgical excision

© 2013 Canadian Medical Association

remains a critically important component of treatment. For this reason the variability in results among surgeons has been widely studied.

Variability in rectal cancer outcomes became an area of active research after the landmark study by Heald and Ryall[1] in 1986 reporting a 5-year local recurrence (LR) rate of 5% when typical rates of 5-year LR following resection of rectal cancer were 25%–40%. Despite this description of the total mesorectal excision (TME) technique, there remained considerable variability in outcomes among surgeons.

In 1998, Porter and colleagues[2] published a study examining the outcomes of patients with rectal cancer undergoing surgery between 1983 and 1990 in Edmonton, Alta. This study, performed in an era preceding widespread adoption of TME, identified a 5-year LR rate of 33% and demonstrated a definite improvement in both 5-year LR and disease specific survival (DSS) for patients with rectal cancer treated by surgeons who had subspecialty colorectal training and for patients of high-volume surgeons. Since the publication of this study, other similar studies have been performed; most[3–6] but not all[7,8] have reported similar results. These studies are often cited to support the idea of regionalizing the care of patients with rectal cancer to fewer, higher-volume, specialized surgical units.

Over the past 15 years, the surgical community has accepted the importance of TME for rectal cancer, and it has now become the standard of care in many countries.[9] In 1999, Dr. Bill Heald visited Edmonton to give grand rounds on the TME technique, and the rounds were followed by a live televideo demonstration of TME in the operating room. Also, substantial advances have been achieved in adjuvant and neoadjuvant therapy for rectal cancer. As late as the early 1990s, the standard of care for T3, T4 or node-positive rectal cancer was postoperative chemoradiation therapy, which has now been shown to be inferior to today's preoperative regimens.[10]

The goals of the present study were to examine, in the same geographic area, the outcomes of patients with rectal cancer treated in the period after publication of the study by Porter and colleagues[2] to determine whether results had improved and whether practice patterns had changed. We also aimed to examine the factors associated with rates of local recurrence and DSS and, specifically, whether surgical volume and/or colorectal training had a clinically important effect on these outcomes.

Methods

Edmonton, Alta. (population 1 million), has a large academic medical centre affiliated with the University of Alberta. Within this academic medical complex lies the Cross Cancer Institute (CCI), which houses the Alberta Cancer Registry. Through the legal mandate of the Canada Health Act, each patient with diagnosed cancer in Alberta is included in this registry. The CCI houses all the charts pertaining to patients treated for cancer in Northern Alberta (population 1.7 million) and includes demographic data, preoperative data, neoadjuvant or adjuvant treatment data, operative reports, pathological data and follow-up data. We searched the registry to identify all patients with rectal cancer in Northern Alberta diagnosed from Jan. 1, 1998, to Dec. 31, 2003. We used the cancer registry database for essentially the same population studied by Porter and colleagues.[2] The Alberta Cancer Board provided ethical approval for this study.

We used the cancer registry to identify patients with primary adenocarcinoma of the rectum who underwent a potentially curative low-anterior resection, abdominoperineal resection or Hartmann resection within our study period. A rectal cancer was defined as an adenocarcinoma 4 cm to 16 cm from the anal verge. If this information was unavailable, only lesions at or below the peritoneal reflection were considered a rectal cancer. A potentially curative resection was defined as a procedure leading to grossly negative surgical margins and the absence of metastatic disease.

All of the patients' charts housed at the CCI were identified, and the first author (J.-S.P.) conducted a standardized review of the charts. If information was unavailable, we consulted and reviewed individual hospital charts. If information essential for our study, such as surgeon name, hospital name, date of the procedure or type of procedure performed was unavailable, the chart was classified as incomplete and excluded. If a chart did not include a recurrence documented by a physician, indicate a follow-up period of at least 5 years after the operation or show that the patient was recurrence-free after 5 years, we considered the patient to be lost to follow-up and excluded that patient from our survival analysis.

We excluded patients who had stage 4 lesions and those who underwent any other type of resection not stated previously (e.g., transanal excisions, Kraske operation). Demographic characteristics and preoperative, intraoperative, pathologic and outcome variables were collected from the provincial registry as well as from individual patient charts using a standardized data collection form.

Neoadjuvant radiation, when used, consisted of either a short-course regimen of 2500 cGy fractionated over 5 days or a long-course regimen of 5000 cGy fractionated over 5–6 weeks with a continuous infusion of fluorouracil. Adjuvant radiation therapy was similar to the long-course regimen mentioned previously and was usually administered 6–8 weeks after the resection. Radiation therapy with or without chemotherapy was categorized as none, neoadjuvant or adjuvant.

The level of the rectal cancers was defined as height above the anal verge according to preoperative assessment by the surgeon via flexible/rigid endoscopy or digital rectal examination. We classified levels as low (4–5 cm) midlevel (6–10 cm) and high (> 10 cm).

We considered general surgeons who completed fellowship-level training in colorectal surgery to be subspecialty-trained colorectal surgeons. Senior members of the Division of General Surgery at the University of Alberta were able to identify all subspecialty-trained colorectal surgeons in practice during our study period. We considered surgeons to be high-volume surgeond if they performed on average more than 3 rectal cancer resections per year during the study period. This cut-off was chosen a priori to match the threshold used in the study by Porter and colleagues,[2] who reported a cut-off of 21 resections performed in an 8-year period, and to allow the appropriate categorization of surgeons who were not practising for the entire duration of our study period into the high-volume group.

Table 1. Demographic and clinical characteristics of the study cohort (*n* = 433)

Characteristic	No. (%)*†
Sex, male	262 (61)
Age, mean (SD) yr	65 (12)
Resection, by training and volume	
High-volume, colorectal	150 (35)
High-volume, no subspecialty training	128 (30)
Low-volume, no subspecialty training	155 (36)
Adjuvant/neoadjuvant therapy	
None	171 (39)
Neoadjuvant therapy	175 (40)
Adjuvant therapy	87 (20)
Operative level	
0–5 cm	94 (22)
6–10 cm	121 (28)
11–15 cm	46 (11)
Missing data	172 (39)
Stage	
1	113 (26)
2	197 (45)
3	122 (28)
Missing data	1 (0.2)
Grade	
1	35 (8)
2	346 (80)
3	31 (7)
Missing data	21 (5)
Lymphovascular invasion	
Yes	69 (16)
No	292 (67)
Missing	72 (17)
Operation	
LAR	231 (53)
APR	186 (43)
Hartmann	16 (4)

APR = abdominoperineal excision; LAR =low anterior resection; SD = standard deviation.
*Unless otherwise indicated.
†Percentages may not add up to 100% owing to rounding.

For the purpose of our study, we defined obstruction as the presence of obstruction leading to an emergency resection.

Primary outcomes included LR and DSS. We considered LR to be the presence of any anastomotic, pelvic or perineal recurrence proven by histology or, if unavailable, sequential radiologic studies detecting enlargement of a pelvic mass. We defined DSS as the absence of death attributable to rectal cancer.

Owing to the fact that colorectal subspecialty training and higher volume were related, which is evidenced by the fact that there were not any subspecialty-trained colorectal surgeons in the low-volume group, we chose to separate the surgeons into 3 groups: subspecialty-trained, high-volume colorectal surgeons (group 1), high-volume surgeons without subspecialty training in colorectal surgery (group 2) and low-volume surgeons without subspecialty training in colorectal surgery (group 3).

Statistical analysis

We calculated means and standard deviations (SD) for continuous data and frequencies (%) for categorical data. We performed independent *t* tests to assess the difference between the means of 2 groups and χ^2 tests to compare the proportions of categorical variables. Fisher exact tests were used when the cell frequency in a 2 × 2 table were less than 5. We created Kaplan–Meier survival curves for LR and DSS,[11] and log rank statistics were used to compare the survival curves.[12] Univariate analysis was performed for the LR and DSS using the log rank test.[12] Multivariate analysis for LR and DSS was performed using the Cox proportional hazard model.[13] The proportional hazard model assumption was tested for the Cox model. We examined the following variables to identify the risk factors of LR and DSS in a univariate analysis: subspecialty-trained colorectal surgeon (yes v. no), surgeon volume (≥ 3 cases/yr v. < 3 cases/yr), patient age (40–59 yr, 60–79 yr, > 80 yr v. < 40 yr), adjuvant therapy (yes v. no), lymphovascular or perineural invasion (yes v. no), distal margin (< 2 cm v. ≥ 2 cm), radial margin (< 1 mm v. ≥ 1 mm), perforation (yes v. no), grade (grade 2 and 3 v. grade 1), stage (stage 2 and 3 v. stage 1), tumour level (mid and high v. low), obstruction (yes v. no) and blood transfusion (yes v. no). Statistically significant variables from the univariate analysis at $p < 0.10$ were entered into the multivariate analysis for LR and DSS. Significant variables ($p < 0.05$) were considered for the final model for LR and DSS. The best-fit model based on Akaike information criterion goodness of fit statistics was used for our final model for LR and DSS. However, colorectal training and number of resections performed were forced in the final model despite these variables not being significant on univariate analysis. Our choice to include subspecialty training in colorectal surgery and number of resections performed in the final model was based on our hypothesis, which was to test the performance of thes variables, controlling for other important factors. We performed 2-tailed tests, and we considered results to be significant at $p < 0.05$. All statistical analysis was performed using SAS version 9.1.3 (SAS Institute Inc.).

Results

A total of 660 patients were identified as having had a rectal adenocarcinoma diagnosed during our study period. Of these, we excluded 205 patients: 114 had metastatic disease, 53 did not undergo a resection, 29 had local excisions, 5 had their resection performed elsewhere, 2 were incorrectly coded in the database as having rectal malignancies, 1 was confirmed not to be adenocarcinoma on final pathology and 1 had a resection of a local recurrence from a previous rectal cancer. Of the remaining 455 patients, 433 (95.2%) had a full 5-year follow-up and were included in the study. The CCI housed complete records for 66% of our study population (287 patients). For the remainder of the patients, further information had to be obtained from

Table 2. Association between subspecialty training and surgical volume

Training	Low volume, < 3/yr	High volume, ≥ 3/yr	No (%)
No subspecialty training	155	128	283 (65)
Colorectal	0	150	150 (35)
Total	155 (39)	278 (61)	433 (100)

Table 3. Demographic characteristics and preoperative, operative and pathology variables

	Group, no. (%)*				
Variable	All patients	High-volume, colorectal	High-volume, no subspecialty training	Low-volume, no subspecialty training	*p* value
Sex, male	262 (61)	81 (54)	78 (61)	103 (66)	0.08
Age, yr	65	65	65	66	0.99
Obstruction	13 (3)	6 (4)	3 (2)	4 (3)	0.17
Tumour Level					0.41
Low	94 (36)	31 (32)	30 (45)	33 (33)	
Mid	121 (46)	45 (47)	27 (41)	49 (49)	
High	46 (18)	20 (21)	9 (14)	17 (17)	
Missing data	172	54	62	56	
Intraop perforation	12 (3)	6 (4)	2 (2)	4 (3)	0.46
Procedure					0.008
LAR	231 (53)	98 (65)	61 (48)	72 (46)	
APR	186 (43)	49 (33)	62 (48)	75 (48)	
Hartmann	16 (4)	3 (2)	5 (4)	8 (5)	
Missing data, no.	0	0	0	0	
Stage					0.26
1	113 (26)	34 (23)	32 (25)	47 (30)	
2	197 (46)	78 (52)	57 (45)	62 (40)	
3	122 (28)	37 (25)	39 (30)	46 (30)	
Missing data, no.	1	1	0	0	
Grade					0.30
1	35 (9)	14 (10)	12 (10)	9 (6)	
2	346 (84)	121 (86)	100 (81)	125 (84)	
3	31 (8)	6 (4)	11 (9)	14 (9)	
Missing data, no.	21	9	5	7	
Blood transfusion	162 (37)	41 (27)	52 (41)	69 (45)	0.006
Missing data, no.	105	28	30	47	
LVI/PNI	69 (16)	27 (18)	17 (13)	25 (16)	0.56
Missing data	73	18	21	34	
Size (mean), cm	3.1	3.1	3.1	3.2	0.70
Missing data	0	0	0	0	
Distal margin ≤ 2 cm	97 (26)	34 (26)	26 (25)	37 (27)	0.94
Missing data	19	7	7	5	
Radial margin, ≤ 1 mm	56 (16)	18 (15)	21 (20)	17 (13)	0.35
Missing data	75	28	22	25	
Neoadj/Adj therapy	262 (61)	93 (62)	81 (63)	88 (57)	0.48
Preop long course RT	158 (60)	55 (59)	57 (70)	46 (52)	0.002
Preop short course RT	17 (6)	12 (13)	2 (3)	3 (3)	
Postop RT	87 (33)	26 (28)	22 (27)	39 (44)	
Missing data	0	0	0	0	

Adj = adjuvant; APR = abdominoperineal resection; DSS = disease-specific survival; intraop = intraoperative; LAR = lower anterior resection; LR = local recurrence; LVI = lymphovascular space invasion; neoadj = neoadjuvant; PNI = perineural invasion, postop = postoperative; preop = preoperative; RT = radiotherapy.
*Unless otherwise indicated.

individual hospital charts. Data on the latest follow-up were most frequently missing. Patients with less than 5 years of follow-up (n = 22) were considered to be lost to follow-up and were not included in the survival analysis.

Table 1 summarizes the demographic and clinical characteristics of the study cohort. The sphincter preservation rate was 53%. The 433 patients included in the study were treated by 42 different surgeons, 5 of whom were colorectal surgeons and 9 of whom were high-volume surgeons (≥ 3 resections per year). As expected, all 5 colorectal surgeons were considered high-volume surgeons; they performed average ranges of 5 to 9.4 resections per year. The average ranges for surgical volume for the surgeons in groups 2 and 3 were 5–7.6 and 0.6–2.8 resections per year in the study respectively (Table 2).

The 5 colorectal surgeons performed 150 (35%) of the surgeries in our study. On univariate analysis and compared with patients treated by surgeons without subspecialty training in colorectal surgery, patients treated by colorectal surgeons were more likely to undergo a sphincter

Table 4. Univariate analysis of factors associated with local recurrence and disease-specific survival

Variable	5-year LR, %	*p* value	5-year DSS, %	*p* value
Group		0.61		0.07
High-volume, colorectal	92.1		87.9	
High-volume, no subspecialty training	91.3		75	
Low-volume, no subspecialty training	93.4		84.7	
Obstruction		< 0.001		< 0.001
Yes	54.7		34.2	
No	93.4		84.2	
Tumour level		0.66		0.31
Low	89.7		84.5	
Mid	93.2		87.7	
High	92.6		97.4	
Blood transfusion		0.22		0.14
Yes	93.7		80.4	
No	89.9		84.2	
Perforation		0.34		0.57
Yes	100		71.6	
No	92.1		83.1	
Stage		0.044		< 0.001
1	95.9		96	
2	92.9		86.4	
3	88.2		65.5	
Grade		0.10		0.005
1	100		90.7	
2	92.0		83.8	
3	86.0		69.2	
LVI/PNI		0.08		0.001
Yes	86.1		70	
No	93.4		84	
Operation		0.34		0.028
LAR	90.8		85	
APR	93.5		79.7	
Age, yr		0.11		0.17
< 40	98		89.5	
40–59	95.2		85.6	
60–79	89.4		80	
≥ 80	94.4		83.9	
Radial margin < 1 mm		0.30		0.040
Yes	92.3		72.7	
No	89.9		84.3	
Distal margin < 2 cm		0.09		0.34
Yes	95.1		79	
No	89.3		83	
Neoadjuvant/adjuvant therapy		0.51		0.008
Yes	91.2		78.5	
No	94.1		89.6	
Hospital		0.15		0.07
1	87.9		76.2	
2	91.9		88.8	
3	93.8		87.1	
4	91.9		79.4	
5	95.2		98.9	
6	97.4		88.7	

APR = abdominoperineal resection; DSS = disease specific survival; LAR = lower anterior resection; LR = local recurrence; LVI = lymphovascular space invasion; PNI = perineural invasion.

sparing procedure and were less likely to have an intraoperative blood transfusion. There were no differences seen between the groups for sex, obstruction, tumour level, perforation, stage, grade, lymphovascular space invasion (LVI)/perineural invasion (PNI), tumour size, margin status or use of neoadjuvant/adjuvant therapy (Table 3).

Local recurrence

The 5-year LR rate of the entire study was 7.4%. On univariate analysis, LR rates did not differ significantly among the 3 surgeon groups. Obstruction and stage were significant at the $p < 0.10$ level for an increased risk of LR on univariate analysis (Table 4).

On multivariate analysis, there were no significant associations between surgeon group and LR. The only variable on multivariate analysis found to be associated with an increased risk of LR was obstruction (Table 5).

Disease-specific survival

The 5-year DSS rate for the entire cohort was 81%. On univariate analysis, DSS was not found to be significantly different among the groups. Factors found to be associated with a decreased DSS on univariate analysis included obstruction, tumour stage, grade, LVI/PNI, operation type, the use of adjuvant/neoadjuvant therapy and radial margin less than 1 mm (Table 4).

On multivariate analysis, compared with high-volume colorectal surgeons, high-volume surgeons without subspecialty training in colorectal surgery were associated with a significantly lower DSS whereas low-volume surgeons without subspecialty training in colorectal surgery were not. Obstruction and stage were significantly associated with 5-year DSS (Table 6).

Comparison of our results to those of Porter and colleagues[2]

Table 7 compares our results to those from the earlier study from our institution by Porter and colleagues.[2] While there were the same number of colorectal surgeons in each study, a greater proportion of cases in our study were performed by surgeons with subspecialty training (35% v. 16%). Likewise, a greater proportion of the cases in our study were performed by high-volume surgeons (64% v. 53%). The most important finding was that both the overall 5-year LR (7% v. 33%) and the 5-year DSS (81% v. 59%) were significantly improved in our study. However, whereas the differences in LR and DSS between surgeons with and without subspecialty training in colorectal surgery as well as between high- and low-volume surgeons was significant in both univariate and multivariate analyses in the previous study, our study found that only the effect of training on DSS remained significant.

Discussion

Our study has confirmed what has been shown in previous studies,[14,15] namely that the long-term oncologic outcomes for rectal cancer have improved dramatically in the last 2 decades. There are several possible explanations for these improved outcomes: improved screening, more effective chemotherapeutics, better selection and delivery

Table 5. Cox proportional hazard regression model using local recurrence as the outcome variable

Variable	HR (95% CI)	*p* value
Group		
High-volume, colorectal*	1	
High-volume, no subspecialty training	1.90 (0.77–4.71)	0.17
Low-volume, no subspecialty training	1.51 (0.54–4.18)	0.43
Obstruction	3.80 (1.26–11.43)	0.018
Stage		
1*	1	
2	2.02 (0.66–6.20)	0.22
3	2.73 (0.85–8.80)	0.09
Hospital		
1*	1	
2	2.50 (1.02–6.14)	0.045
3	0.31 (0.07–1.43)	0.13
4	1.60 (0.41–6.17)	0.50
5	0.71 (0.09–5.60)	0.75
6	0.88 (0.11–7.30)	0.90
LVI/PNI	1.48 (0.60–3.69)	0.40

CI = confidence interval; HR = hazard ratio; LVI = lymphovascular space invasion; PNI = perineural invasion.
*Reference group.

of radiation treatment, improved imaging and increased use of multidisciplinary tumour conferences. Considering the variability among the different surgical groups that is still evident, surgical technique is obviously also a factor. There was a slight decrease in the number of surgeons performing rectal cancer resections in our study, and this concentration of surgical care is a potential explanation of the improvement in 5-year DSS or LR rates. Also, the study by Porter and colleagues[2] and R.J. Heald's visit in 1999 could be seen as a form of audit and feedback, which has been shown to be effective in improving professional practice.[16] Events such as these may have had an impact and helped improve our outcomes, although we do not know what percentage of surgeons included in this study read the paper or were present for the lecture. Therefore, one of the possible explanations for these dramatic improvements is the widespread adoption of TME by surgeons treating rectal cancer. It has been shown in previous studies that the improved quality of surgery, namely adherence to the principles of TME, contributes substsantially to improved outcomes.[17] However, this theory is difficult to prove in our study because data on the grading of mesorectum were not yet widely reported by pathologists during our study period and because operative reports were very inconsistent in the reporting of the TME technique. The other main contributing factor to our improved outcomes is the more common use of neoadjuvant therapy, which has also been shown to be efficacious in improving LR[18,19] and DSS.[20]

The popular belief among surgeons is that there are certain procedures that require either prolonged training and/or a certain volume to obtain and maintain competence. This has been well established by Birkmeyer and colleagues[21] and others for certain advanced procedures. Whereas surgical specialization for rectal cancer resections does have support in the literature in terms of improving DSS,[22] the benefit of increased surgical volume is not as clear. In fact, a recent systematic review did not find a significant association between high-volume surgeons and long-term outcomes.[7] The results of our retrospective study mirror these findings, and we found that volume was not associated with improved LR or DSS.

Subspecialty training in colorectal surgery was associated with an oncological benefit, evidenced by the fact that among high-volume surgeons, the patients of colorectal surgeons had improved DSS. Surprisingly, when comparing high-volume colorectal surgeons and low-volume surgeons without subspecialty training in colorectal surgery, this improvement in DSS was no longer seen. While we are unable to conclusively determine why this was the case, we can hypothesize that there may be an element of selection bias involved that was not captured by our demographics. This may include factors such as obesity or previous pelvic surgery.

In addition to our main outcomes, colorectal surgeons had higher sphincter preservation rates than surgeons

Table 6. Cox proportional hazard regression model using disease-specific survival as the outcome variable

Variable	HR (95% CI)	*p* value
Group		
High-volume, colorectal*	1	
High-volume, no subspecialty training	3.14 (1.73–5.72)	0.002
Low-volume, no subspecialty training	2.19 (1.13–4.21)	0.019
Obstruction	3.09 (1.51–6.32)	0.002
Stage		
1*	1	
2	3.68 (1.42–9.49)	0.007
3	9.04 (3.53–23.10)	< 0.001
Hospital		
1*	1	
2	2.12 (1.21–3.73)	0.009
3	0.44 (0.21–0.93)	0.032
4	1.29 (0.52–3.15)	0.58
5	0.47 (0.11–1.95)	0.30
6	0.50 (0.12–2.17)	0.36

CI = confidence interval; HR = hazard ratio.
*Reference group.

Table 7. Comparison of results from the previous study by Porter and colleagues with those of the present study

Factor	Porter et al.[2]	Present study
Study period	1983–1990	1998–2004
No. cases	683	433
Age, mean, yr	65	65
Total surgeons, no.	52	42
Colorectal surgeons, no.	5	5
Cases by colorectal surgeons, no. (%)	109 (16)	150 (35)
High-volume surgeons, no.	NA	9
Cases by high-volume surgeons, no. (%)	360 (53)	278 (64)
Chemotherapy/radiation therapy, no. (%)	432 (64)	171 (39)
Neoadjuvant therapy, no. (%)	68 (11)	175 (40)
Adjuvant therapy, no. (%)	169 (25)	87 (20)
Overall 5-year DSS, %	59	81
Overall 5-year LR, %	33	7
Colorectal trained surgeons LR, %	13.4*	8.7
Non-colorectal trained surgeons LR, %	37.4*	6.7
Effect of training on 5-year LR, HR†	2.49*	1.03
Colorectal trained surgeons DSS, %	61*	86
Non-colorectal trained surgeons DSS, %	44*	79
Effect of training on 5-year DSS, HR†	1.52*	1.85*
High volume surgeons LR, %	26.0*	8.3
Low volume surgeons LR, %	42.2*	5.8
Effect of volume on 5-year LR, HR†	1.80*	0.70
High volume surgeons DSS, %	54*	80
Low volume surgeons DSS, %	39*	84
Effect of volume on 5-year DSS, HR†	1.40*	0.62

DSS = disease specific survival; HR = hazard ratio; LR = local recurrence; NA = not available.
*Statistically significant ($p < 0.05$).
†Multivariate analysis.

without subspecialty training in colorectal surgery. This is an important finding in that this has been shown to improve morbidity and to be associated with improved LR.[23] There was also a lower transfusion rate in the colorectal surgeon group, which may imply higher-quality surgery with less blood loss.

An obstruction leading to an emergency resection, although rare (n = 13), was associated with significantly worse oncologic outcomes. It was in fact the only variable that was found to be associated with an increased LR and a worse DSS. To our knowledge, an emergent proctectomy for obstruction has never been shown to be a significantly negative prognostic factor. Although we did not compare these patients to those who were obstructed and initially diverted, this does suggest that emergency resections for rectal cancer should not be undertaken.

Limitations

The limitations of our study include its retrospective design. As such, when the charts were incomplete, we were unable to collect or verify certain variables. Also, while the CCI was a central database for all patients with rectal cancers in northern Alberta, some of communities are remote; therefore, if the information was incomplete in the central database, we were less likely to be able to complete that chart because the hospital charts were not readily accessible. Also, because there is not an accepted definition of high volume, we chose to define it as 3 resections or more per year to better compare our results with those of Porter and colleagues.[2] We did, however try different cutoffs for high and low volume, and it did not affect our results. Nonetheless, most experts would consider 3 resections to be too low to qualify as high volume for colorectal surgeons. In addition, as a rectal cancer was defined in our registry as being 4 cm to 16 cm from the anal verge, it is likely that the lowest cancers have been excluded. This is a potentially important concern, as the lowest cancers are associated with the highest LR rates.

Conclusion

Over the past 10 years, there are fewer surgeons performing rectal cancer surgery in Northern Alberta, colorectal surgeons are performing a larger proportion of cases, and the long-term outcomes have substantially improved. We found that among high-volume surgeons, surgical subspecialization was associated with improved DSS but not LR. We hypothesize that the improved results are at least partly due to more widespread adoption of the TME techniques by surgeons in our centre. This would need to be verified with a follow-up study now that mesorectal grading has been adopted.

Competing interests: None declared.

Contributors: J.-S. Pelletier, C. de Gara and D. Schiller designed the study. J.-S. Pelletier acquired and analyzed the data. G. Porter, S. Ghosh and D. Schiller also analyzed the data. J.-S. Pellletier wrote the article, which all authors reviewed and approved for publication.

References

1. Heald RJ, Ryall RD. Recurrence and survival after total mesorectal excision for rectal cancer. *Lancet* 1986;1:1479-82.
2. Porter GA, Soskolne CL, Yakimets WW, et al. Surgeon-related factors and outcome in rectal cancer. *Ann Surg* 1998;227:157-67.
3. Martling A, Cedermark B, Johansson H, et al. The surgeon as a prognostic factor after the introduction of total mesorectal excision in the treatment of rectal cancer. *Br J Surg* 2002;89:1008-13.
4. Salz T, Sandler RS. The effect of hospital and surgeon volume on outcomes for rectal cancer surgery. *Clin Gastroenterol Hepatol* 2008;6:1185-93.
5. McArdle CS, Hole DJ. Influence of volume and specialization on survival following surgery for colorectal cancer. *Br J Surg* 2004;91:610-7.
6. Read TE, Myerson RJ, Fleshman JW, et al. Surgeon specialty is associated with outcome in rectal cancer treatment. *Dis Colon Rectum* 2002;45:904-14.
7. Gruen RL, Pitt V, Green S, et al. The effect of provider case volume on cancer mortality: systematic review and meta-analysis. *CA Cancer J Clin* 2009;59:192-211.
8. Ng VV, Tytherleigh MG, Fowler L, et al. Subspecialisation and its effect on the management of rectal cancer. *Ann R Coll Surg Engl* 2006;88:181-4.
9. Peeters KC. The TME trial after a median follow-up of 6 years. *Ann Surg* 2007;246:693-701.
10. Goodwin RA, Asmis TR. Overview of systemic therapy for colorectal cancer. *Clin Colon Rectal Surg* 2009;22:251-6.
11. Kaplan EL, Meier P. Nonparametric estimation from incomplete observations. *J Am Stat Assoc* 1958;53:457-81.
12. Peto R, Peto J. Asymptotically efficient rank invariant test procedures. *J R Stat Soc [Ser A]* 1972;135:185-207.
13. Cox DR. Regression models and life-tables. *J R Stat Soc B* 1972;34:187-220.
14. Bülow S, Harling H, Iversen LH, et al. Improved survival after rectal cancer in Denmark. *Colorectal Dis* 2010;12:e37-42.
15. Wibe A, Carlsen E, Dahl O, et al. Nationwide quality assurance of rectal cancer treatment. *Colorectal Dis* 2006;8:224-9.
16. Ivers N, Jamtvedt G, Flottorp S, et al. Audit and feedback: effects on professional practice and healthcare outcomes. *Cochrane Database Syst Rev* 2006;6:CD000259.
17. MacFarlane JK, Ryall RDH, Heald RJ. Mesorectal excision for rectal cancer. *Lancet* 1993;341:457-60.
18. Kapiteijn E, Marijnen C, Nagtegaal ID, et al. Preoperative radiotherapy combined with total mesorectal excision for resectable rectal cancer. *N Engl J Med* 2001;345:638-46.
19. Sauer R, Becker H, Hohenberger W, et al. Preoperative versus postoperative chemoradiotherapy for rectal cancer. *N Engl J Med* 2004;351:1731-40.
20. Improved survival with preoperative radiotherapy in resectable rectal cancer. Swedish Rectal Cancer Trial. *N Engl J Med* 1997;336:980-7.
21. Birkmeyer JD, Stukel TA, Siewers AE, et al. Surgeon volume and operative mortality in the United States. *N Engl J Med* 2003;349:2117-27.
22. Iversen LH, Harling H, Laurberg S, et al.; the Danish Colorectal Cancer Group. Influence of caseload and surgical speciality on outcome following surgery for colorectal cancer: a review of evidence. Part 2: Long-term outcome. *Colorectal Dis* 2007;9:38-46.
23. Konn M, Morita T, Hada R, et al. Survival and recurrence after low anterior resection and abdominoperineal resection for rectal cancer: the results of a long-term study with a review of the literature. *Surg Today* 1993;23:21-30.