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ORIGINAL ARTICLE

Rectal cancer surgery: does low volume imply worse outcome—a single surgeon experience

Niamh A. Dundon[1] · Adel Hassan Al Ghazwi[1] · Matthew G. Davey[1] · William P. Joyce[1,2]

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Abstract

Background The centralisation of rectal cancer management to high-volume oncology centres has translated to improved oncological and survival outcomes. We hypothesise that individual surgeon caseload, specialisation, and experience may be as significant in determining oncologic and postoperative outcomes in rectal cancer surgery.

Methods A prospectively maintained colorectal surgery database was reviewed for patients undergoing rectal cancer surgery between January 2004 and June 2020. Data studied included demographics, Dukes' and TNM staging, neoadjuvant treatment, preoperative risk assessment scores, postoperative complications, 30-day readmission rates, length of stay (LOS), and long-term survival. Primary outcome measures were 30-day mortality and long-term survival compared to national and international standards and best practice guidelines.

Results In total, 87 patients were included (mean age: 66 years [range: 36–88]). The mean length of stay (LOS) was 16.5 days (SD 6.0). The median ICU LOS was 3 days (range 2–17). Overall, 30-day readmission rate was 16.4%. Twenty-four patients (26.4%) experienced ≥ 1 postoperative complication. The 30-day operative mortality rate was 3.45%. Overall 5-year survival rate was 66.6%. A significant correlation was observed between P-POSSUM scores and postoperative complications ($p = 0.041$), and all four variants of POSSUM, CR-POSSUM, and P-POSSUM scores and 30-day mortality.

Conclusion Despite improved outcomes seen with centralisation of rectal cancer services at an institutional level, surgeon caseload, experience, and specialisation is of similar importance in obtaining optimal outcomes within institutions.

Keywords Caseload · Hospital volume · Outcomes · Rectal cancer

Introduction

National Cancer Registry Ireland (NCRI) data have illustrated an increase in the incidence of rectal cancer in Ireland in recent times, with rectal cancer diagnoses increasing from 12.33 per 100,000 in 1994 to 13.78 in 2015 [1]. Overall, this represents 2.98% of all invasive tumours diagnosed in the Republic of Ireland. Rectal carcinoma is significantly prevalent in the West of Ireland, where 14.49 patients are diagnosed per 100,000 population at risk annually [1]. Thus, robust evaluation of surgical and oncological outcomes is imperative to ensure patient outcomes are optimised where possible.

The centralisation of cancer services to centres of excellence has been established in the Republic of Ireland for many years and is well documented for the treatment of breast, prostate, lung, and upper gastrointestinal cancers [2, 3]. In 2007, a national centralisation initiative for the surgical management of rectal cancer was initiated following a national clinical audit of rectal cancer care [4]. Prospective studies involving 29 colorectal surgeons in 14 centres acknowledged a high standard of surgical care of rectal cancer patients at that time [4], but called for the development of national evidence-based guidelines regarding the standardisation of rectal cancer surgery and the use of neoadjuvant treatment modalities in selected cases.

Increased hospital volume of cases treated may be associated with improved outcomes, operative mortality, and better 5-year survival for many conditions, including pancreatectomy, oesophagectomy, and invasive cardiovascular procedures [5–7]. Similar reports have shown more favourable results for the management of patients with rectal cancer

✉ Niamh A. Dundon
niamh.dundon1@gmail.com

[1] Department of Surgery, Galway Clinic, Galway, Ireland

[2] Royal College of Surgeons in Ireland, Dublin, Ireland

in high-volume centres [8–11]. However, others have suggested that individual surgeon caseload [12, 13], surgeon specialisation, and experience may be more significant than gross hospital volume in improving postoperative outcomes in rectal cancer surgery [12, 14, 15]. Speculation in relation to the correlation between hospital surgical volume and postoperative outcomes may in fact be due to the advanced systems of care [15] offered by these institutions, in tandem with the expertise of the surgeons involved [5].

Volume-outcome measures are widely reported as an auditable benchmark for improvements in patient care. High-to-low volume thresholds vary enormously between studies, making accurate comparisons problematic. In the UK, the National Institution for Health and Care Excellence (NICE) [16] recommends that centres performing rectal cancer surgery should perform at least 10 such procedures per year. In addition, NICE advise that individual surgeons complete a minimum of 5 of these operations per annum to meet these basic standards [16].

As a single surgeon study in a low-volume, independent institution, we hypothesised that optimal surgical and oncological outcomes may be achieved in rectal cancer surgery, which is comparable to high-volume centres and is in keeping with best international practice.

Methods

Data sources and study population

A retrospective review of a prospective single-surgeon colorectal database was performed. This database consisted of patients who underwent surgery with curative intent for colorectal disease by a single surgeon between January 1st, 2004 and June 30th, 2020 at a tertiary referral private teaching hospital.

Study variables

The pre-defined database included all baseline patient characteristics, such as age, gender, body mass index (BMI) and smoking status, as well as preoperative risk assessments, including physiological and operative severity score for the enumeration of mortality and morbidity (POSSUM)[17], Portsmouth-physiological and operative severity score for the enumeration of mortality and morbidity (P-POSSUM) [18] and colorectal physiological and operative severity score for the enumeration of mortality and morbidity (CR-POSSUM)[19] scores, electrocardiogram (ECG) findings, American Society of Anesthesiologists (ASA)[20] grade, respiratory and cardiovascular health.

Tumour characteristics identified included Duke's [21] staging, tumour node metastasis (TNM) staging [22], histological diagnosis and site of pathology. Clinical and operative details such as neoadjuvant therapy, operation performed, estimated blood loss, stoma formation and adjuvant therapy were also recorded.

Finally, postoperative outcomes focused on intensive care unit (ICU) and non-ICU length of stay (LOS), 30-day readmission rate, 30-day morbidity and mortality, and overall long-term survival. Assessment of local recurrence in all patients was forensically analysed for the long-term survival dataset. Differences between variables were calculated for the categories of operation performed or site of pathology for purposes of analysis.

Outcomes

The primary outcome measures were 30-day mortality and long-term survival, compared to national and international standards and best practice guidelines. Secondary outcome measures included 30-day readmission, ICU- and non-ICU length of stay, postoperative complications, and local recurrence rates.

Statistical analyses

All data were analysed using IBM SPSS Statistics (Version 26.0, IBM, Armonk, NY, USA). Missing data were not amended by case deletion or imputation methods; therefore, denominators indicate definite reported cases only, as in Jonker et al. [23]. Comparative analyses of nominal variables were conducted using the chi-square test, while scale variables were compared between groups using one-way analysis of variance (ANOVA). As the data were skewed, nonparametric Kruskal–Wallis was used following ANOVA to compare the differences in mean ranks for POSSUM morbidity, CR-POSSUM, and P-POSSUM. Kaplan–Meier survival analysis was used to measure differences in overall survival between groups defined by sites of pathology. A p-value < 0.05 was considered statistically significant.

Results

Study population

In total, 493 patients were identified in the database. Patients diagnosed with benign colorectal pathology ($n = 201$), and colorectal cancers proximal to the rectosigmoid junction ($n = 199$) were excluded from this study.

The study group included 87 patients who were treated with curative intent for rectal cancer. These patients were grouped by site of pathology. Cancers of the rectosigmoid junction, upper rectum, mid-rectum, and low rectum were

studied. Six patients ($n=6$) were excluded as they were non-adenocarcinoma/carcinoid tumours. Other patients undergoing conservative management of early (T1) rectal cancers treated by trans-anal excision or other conservative measures were also excluded. The final study population was comprised of a total of 87 patients who underwent surgery for rectal cancer by a single surgeon in the period outlined.

Baseline characteristics

A total of 87 patients who underwent surgical resection with curative intent for rectal cancer were included in the study. Age, BMI, ASA grade, staging, and histological diagnosis showed no statistical difference when compared between sites of pathology (all $p>0.050$). The mean age of patients at diagnosis was 66 years (range: 36–88), with no disparity between the groups. There were no differences observed between preoperative measures of ECG, cardiac, respiratory, and smoking statuses. Baseline characteristics, including overall demographics and those stratified for site of pathology, are shown in Table 1 and Supplementary Table 5, respectively.

Multimodal therapeutics and surgery

Overall, 27.5% of patients received neoadjuvant treatment, with more patients receiving chemoradiation or radiotherapy alone in the mid- and low-rectal groups ($p=0.004$). The majority of patients ($n=55$, 63.2%) underwent a low anterior resection, followed by high anterior resection ($n=17$, 19.5%), and abdominal-perineal resection ($n=10$, 11.5%). Treatment and surgery details are further outlined in Table 1.

Of the 87 patients studied, 97.7% were diagnosed with adenocarcinoma, while two patients (2.3%) were diagnosed with carcinoid tumours of the rectosigmoid junction. Cancers of the rectosigmoid junction, mid rectum, and low rectum were more common in male patients, compared to the upper rectum, where only 40% of patients were male ($p=0.025$). There was a significant difference ($p<0.001$) in the type of operation performed between the site of pathology groups (Supplementary Table 5). One patient (1.1%) underwent a sub-total colectomy and ileorectal anastomosis for a tumour of the rectosigmoid junction, following a previous colostomy for a rectosigmoid obstruction. Another patient underwent a panproctocolectomy for a low rectal tumour, following an earlier left hemicolectomy and high anterior resection for a sigmoid tumour with primary anastomosis, in the setting of long-standing ulcerative colitis.

Table 1 Baseline characteristics of rectal cancer patients

Variable	Number (*N*)	Percentage (%)
Age at diagnosis		
Mean (SD)	65.75 (11.89)	-
Sex		
Male	58	66.7%
Female	29	33.3%
ECG		
Normal sinus rhythm	71	94.7%
Atrial fibrillation	4	5.3%
Respiratory status		
Level 1	69	92%
Level 2	6	8%
Cardiac status		
Level 1	47	62.7%
Level 2	22	29.3%
Level 3	5	6.7%
Level 4	1	1.3%
Smoking status		
Non smoker	51	68%
Ex-smoker	21	28%
Smoker	3	4%
ASA grade		
Grade 1	10	13.3%
Grade 2	40	53.3%
Grade 3	20	26.7%
Grade 4	5	6.7%
Dukes' staging		
A	11	14.7%
B	19	25.3%
C	34	45.3%
D	11	14.7%
T stage		
T1	7	7.9%
T2	17	19.3%
T3	54	61.4%
T4	10	11.4%
N stage		
N1	42	48.3%
N2	30	34.5%
Nx	15	17.2%
Neoadjuvant therapy		
None	63	72.4%
Chemoradiation	21	24.1%
Radiotherapy	3	3.4%
Site of pathology		
Rectosigmoid junction	35	40.2%
Upper rectum	20	23%
Mid Rectum	10	11.5%
Low Rectum	22	25.3%
Histological diagnosis		
Adenocarcinoma	85	97.7%
Carcinoid tumour	2	2.3%

Table 2 Preoperative risk scores and postoperative outcomes of patients undergoing rectal cancer surgery

	Postoperative complications		**30-day mortality**	
	[Mean (SD)]	*P-value*	***[Mean (SD)]***	*P-value*
POSSUM morbidity	0.115 (0.009)	0.073	0.297 (0.305)	0.003*
POSSUM mortality	0.365 (0.288)	0.350	0.680 (0.360)	0.027*
CR-POSSUM	0.037 (0.104)	0.092	0.258 (0.347)	< 0.001*
P-POSSUM	0.038 (0.066)	0.041*	0.099 (0.125)	0.007*

POSSUM, physiological and operative severity score for the enumeration of mortality and morbidity; *CR-POSSUM*, colorectal-POSSUM; *P-POSSUM*, Porstmouth-POSSUM

Preoperative risk assessments

Patients underwent preoperative risk assessments using the combined POSSUM [17] scores, including the CR-POSSUM [19] and P-POSSUM [18] variants. Consequently, there was no difference in preoperative risk of morbidity and mortality observed between operations performed for any of the above risk scores. There was a statistically significant correlation observed between P-POSSUM scores and postoperative complications ($p = 0.041$) and all four variants of POSSUM, CR-POSSUM, and P-POSSUM scores and 30-day mortality (all $p < 0.050$) (Table 2).

Operative outcomes

The average number of rectal cancer surgeries, which included TME, performed over a 16-year period was 5.44 procedures per annum. This did not include trans-anal excisions or other conservative rectal procedures for early (T1) rectal cancers.

The mean recorded length of stay was 16.5 days (standard deviation (SD): 6.0 days). Median ICU length of stay was 3 days (range: 2–17 days). There was no difference in length of stay ($p = 0.107$) or ICU length of stay ($p = 0.160$) between the types of procedures performed (Table 3). The overall 30-day readmission rate was 16.4% and did not differ significantly between groups ($p = 0.194$). 52.9% of patients ($n = 46$) underwent temporary stoma formation, of which 87% ($n = 40$) were following low anterior resection. 11.6% ($n = 10$) underwent a permanent stoma formation following abdominal perineal resection ($p < 0.001$). All temporary stomas in this series were reversed.

Postoperative complications

Twenty-four patients (26.4%) experienced one or more postoperative complications (Table 4). The 30-day operative mortality rate was 3.45% ($n = 3$). This comprised two patients who underwent pelvic clearance for extensive disease and one following a low anterior resection ($p = 0.031$). All three of these patients died due to a fatal myocardial infarction post-op.

Overall five-year survival rate was 66.6% (Fig. 1). Cumulative survival did not differ between sites of pathology (Supplement Fig. 2; $p = 0.317$), TNM stage (Supplement Fig. 3; $p = 0.171$), or Dukes' classification ($p = 0.071$). In addition, no patient in this series developed local pelvic recurrence following primary treatment of their rectal cancer.

Discussion

This retrospective review of rectal cancer patients treated by a single surgeon at a private teaching hospital has shown favourable outcomes that are consistent with national and international standards and best practice guidelines [16, 24–29]. The centralisation of rectal cancer services was

Table 3 Operative outcomes and postoperative complications of rectal cancer patients stratified for operative type

	HAR [*n* = 17 (19.5%)]	**LAR [*n* = 55 (63.2%)]**	**APR [*n* = 10 (11.5%)]**	**Sub-total colectomy [*n* = 1 (1.1%)]**	**Panproctocolectomy [*n* = 1 (1.1%)]**	**Pelvic clearance [*n* = 3 (3.4%)]**	***P*-value**
Length of stay (LOS) [mean (SD)]	14.44 (5.67)	16.29 (5.78)	20.89 (6.19)	12.00	13.00	21.50 (9.19)	*0.107*
ICU LOS [mean (SD)]	3.47 (1.25)	4.04 (2.71)	3.78 (0.67)	2.00	5.00	9.50 (7.78)	*0.160*
30-day readmission	3 (20%)	5 (11.1%)	3 (33.3%)	0 (0%)	1 (100%)	0 (0%)	*0.194*
Postoperative outcomes							
Overall complications	4 (23.5%)	10 (18.2%)	5 (50%)	0 (0%)	1 (100%)	3 (100%)	*0.015**
30-day mortality	0 (0%)	1 (1.8%)	0 (0%)	0 (0%)	0 (0%)	2 (66.7%)	*0.031**
Stoma formation	4 (23.5%)	40 (72.7%)	10 (100%)	0 (0%)	0 (0%)	2 (66.7%)	*< 0.001**
Adjuvant therapy							*0.482*
Chemoradiation	10 (58.5%)	25 (45.5%)	6 (60%)	1 (100%)	0 (0%)	1 (33.3%)	
Radiotherapy alone	0 (0%)	0 (0%)	1 (10%)	0 (0%)	0 (0%)	0 (0%)	

HAR, high anterior resection; *LAR*, low anterior resection; *APR*, abdominal perineal resection

Table 4 Postoperative complications of rectal cancer patients undergoing surgical resection

Complication	Number (*n*)	Percentage (%)
None	63	72.4%
Wound infection	7	8%
Acute urinary retention	4	4.6%
Death	3	3.4%
Respiratory failure	2	2.3%
Myocardial infarction	2	2.3%
Wound dehiscence	1	1.1%
Subacute bowel obstruction	1	1.1%
Post-op haemorrhage	1	1.1%
Pelvic collection	1	1.1%
Ureteric leak	1	1.1%
Lower respiratory tract Infection	1	1.1%
Cardiac arrest	1	1.1%
Stroke	1	1.1%

initiated in Ireland in 2007, with eight surgical centres now designated for the treatment of rectal cancer across the country. Since then, we have witnessed a major overhaul in the management of these patients within the public health system. However, independent hospitals still play a large role in the surgical management of rectal cancer, as exhibited by nationwide audits [24] and the results of the current analysis.

Both surgeon caseload and hospital volume have been extensively studied in the context of rectal cancer surgery and optimisation of outcomes with conflicting results [8–15]. Whilst some studies have shown a correlation between high hospital volume and lower rates of postoperative complications [25], a notable trend has also emerged that shifts focus towards surgical specialisation and experience as predictors of improved outcomes in patient care [12–14]. In this study, the mean annual caseload was 5.44 procedures per year, excluding trans-anal excisions and other

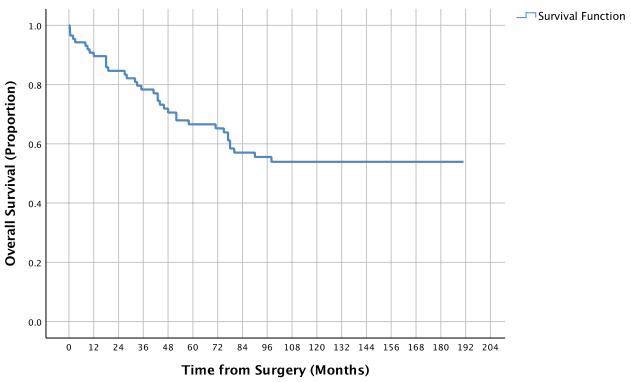

Fig. 1 Kaplan–Meier curve for overall survival. *Overall 5-year survival 66.6%

conservative procedures, which meets the NICE minimum acceptable standards for single surgeon volume for rectal cancer resections [16]. Thus, given these results illustrating outcomes comparable to large volume centres, this study places emphasis on individual surgeon caseload as the most important factor in ensuring the optimisation of surgical outcomes for patients diagnosed with resectable rectal cancer in the Republic of Ireland.

Of the 87 patients studied over the 16-year period in our review, the overall 5-year survival rate was 67%. This compares to the national average of 63% in the eight designated centres and 65% in independent hospitals from 2008 to 2014 [24], and 71% survival with curative intent in a single Dublin centre [26]. Our results reinforce the findings of the NCRI report [24], which demonstrated that rectal cancer patients treated in selected independent hospitals might expect enhanced survival rates relative to those treated in dedicated centres of cancer excellence on a national level. Several factors may be responsible for this disparity; for example, ease of access to diagnostics and surgical assessment afforded by shorter waiting lists in independent hospitals may allow for prompt detection and treatment of early rectal cancers, compared to the public system. While this study addresses this contentious issue at a local level, this of course warrants formal review at a national level.

The UK National Bowel Cancer Audit (NBOCA) reports a 30-day operative mortality rate of 2.9% [27]. They recommend an acceptable rate to be < 5% for elective and < 20% for emergency cases at 90 days. The 30-day operative mortality rate in our analysis was 3.5% ($n=3$). While our cases were exclusively rectal cancer resections, it is worth noting that no distinction was highlighted between colon and rectal surgeries for the NBOCA figures. The recognised complexities of rectal cancer surgery and its associated anatomy likely predispose to higher complication rates overall [28].

It is generally acceptable to use 30-day readmission rates as an indicator of postoperative morbidity [29] and hospital performance [30, 31]. The readmission rate observed in this study was greater than that of the NBOCA study at 16.4%, relative to the 10.8% observed in their study [27]. Again, their estimates combine colon and rectal cohorts, despite evidence from a Canadian study that rectal cancer patients have a significantly higher rate of readmissions (7.1% colon and 10.7% rectal; $p=0.001$) [32]. Rationale for these increased readmission rates likely does not fall with the surgical oncologist alone. Rather, this increased rate may be best explained by the increased availability of emergency surgical beds in the private hospital studied in this analysis, relative to publicly funded hospitals. Most of the readmissions observed in this study related to complications surrounding wound infection ($n=7$) and partial wound dehiscence ($n=1$). In addition, the average general LOS was 16.5 days and ICU LOS was 3.0 days and did not differ between the type of procedure

performed. This compares to the NBOCA estimate of 8 days for both colon and rectal procedures [27]. Although LOS and readmission rates provide valuable insights into patients' postoperative course, the complex nature of patient care limits their precision as markers of quality of care, as thoughtfully illustrated by Fischer et al. [30]

The use of neoadjuvant and adjuvant chemoradiotherapy in rectal cancer varies widely across centres and regions. The NCRI [24] report an increase in the use of multimodal therapy in all centres between 1996 and 2014, with slightly higher rates of use in designated centres (57%) compared with independent hospitals (50%). In total, 24.1% of our patient cohort received neoadjuvant chemoradiation, while 49.4% received adjuvant therapy. All patients assessed and treated in our institution are discussed at weekly multi-disciplinary team meetings, where individualised management plans are put in place in accordance with the latest research and best practice guidelines. Despite our status as a low-volume rectal cancer centre, our surgeon experience and ease of access to advanced imaging techniques and specialist oncology services ensure that all neoadjuvant and adjuvant therapy is provided when clinically indicated.

The role of independent institutions in the provision of cancer services in Ireland and the UK has been cautiously reexamined in the context of the COVID-19 pandemic [33–36]. During the first wave of the pandemic from March to June 2020, the number of cases of cancer detected through the Irish National Cancer Control Programme (NCCP) rapid access clinics was reduced by 23% compared to the same time period in 2019 (1796 cases in 2019 vs. 1377 cases in 2020) [33]. During this time, there were 688 less cancer resections performed, representing a 13% reduction in surgical oncology activity when compared with March to June 2019 [33]. By the year ending December 2020, overall surgical oncology activity within the public sector was 82.2% of 2019. However, when cancer resections performed in the private sector were included through National Histopathology Quality Improvement Programme (NHQI) data, only a 4% reduction (740 cases) in cancer activity was observed [34]. These figures highlight the potential that the private sector has in contributing to Ireland's cancer services going forward and should prompt us to re-evaluate our current system of oncology resource provision.

This study is subject to several limitations. Primarily, this study included a relatively small patient cohort where authors rely on retrospective data, implying inevitable confounding, ascertainment and selection biases. Secondly, a conventional surgical approach to rectal cancer was employed in all cases included in this study, with minimally invasive strategies such as laparoscopic and robotic techniques now the standard of care, despite the higher perioperative costs and intraoperative time involved [37]. Thirdly, several studies have yet to show superiority of robotic and laparoscopic rectal cancer surgery over open resection with regard to postoperative complications and oncological outcomes [38–41]. Robotic rectal cancer resections are not yet performed at our institution and may be considered in the future if favourable patient outcomes and cost–benefit analyses continue to rise.

In conclusion, a high-volume single-surgeon service within a low-volume centre yields optimal outcomes in rectal cancer surgery that are in line with national and international standards and best practice guidelines. While designated centres may have higher surgical volumes, low-volume centres can compete with this standard of care when it is provided by surgeons with adequate experience and specialisation. The role of surgeons in independent, small-volume centres providing care to rectal cancer patients should be strongly considered prospectively, should global emergencies (such as the COVID-19 pandemic) negatively impact the providing of care to our cancer patients in the future.

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Author contribution All listed authors contributed significantly to this research. ND, the primary author, was responsible for interpretation and statistical analysis of the results and was the main contributor to the manuscript. AHAG and MGD were responsible for data collection and preparation. WJ was the supervising author and was a major contributor in finalising the manuscript for publication. All authors read and approved the final manuscript prior to submission.

Availability of data and materials All data included in this study are available for comparative review upon request.

Code availability Data were analysed using IBM SPSS Statistics (Version 26.0, IBM, Armonk, NY, USA).

Declarations

Ethics approval Ethical approval was obtained by the Galway Clinic Ethics Committee, Doughiska, Galway, Ireland.

Consent to participate Not applicable.

Consent for publication The authors consent for this manuscript to be published in its entirety.

Conflict of interest The authors declare no competing interests.

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