Laparoscopic Colorectal Surgery In Rural Australia: A Single Centre Retrospective Study.

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Citation

Y Cho, E Yeboah, T Bowles. *Laparoscopic Colorectal Surgery In Rural Australia: A Single Centre Retrospective Study.*. The Internet Journal of Surgery. 2021 Volume 37 Number 1.

DOI: 10.5580/IJS.55745

Abstract

Introduction: Laparoscopic colorectal surgery is increasingly being offered to patients by general surgeons and has become the standard of care in colorectal surgery. Benefits of laparoscopic colorectal surgery include shorter hospital stay, improved recovery time, cost benefits to health system without compromising oncological outcomes. Rural general surgeons in Australia will face an increasing aging population and with that, an increasing load of cancer surgery. Published work comparing rural surgeons outcomes with that of subspecialised metropolitan colleagues have demonstrated similar outcomes.

All laparoscopic and laparoscopically assisted colorectal operations attempted or performed by a single surgeon from 2008 to 2014 were retrieved from the hospital database. Patient demographics, operating time, length of stay, complications, mortality, and transfer to tertiary centres were analysed using sound statistical methods.

Results: Mean age was 69.26 years and male to female ratio was 1: 1.3. Mean operating time was 156 minutes with LSC (left sided cancer) operations taking significantly longer than RSC (right sided cancer) operations. Median length of stay was 5 days, with LSC patients staying slightly longer but this was not statistically significant. Conversion rate was 5.8%, stoma rate 12.5%, re-admission rate of 3.3%, re-operation rate of 7.5% and mean lymph node harvest of 14.34. Mortality rate was 2.5%.

There was no relationship between length of operating time and complications.

There was also no correlation between length of operation and length of stay in hospital.

Conclusion: Laparoscopic colorectal surgery can be performed in rural Australia by appropriately trained and supported rural general surgeons with comparable outcomes , benefits and savings to the health system.

INTRODUCTION

Since Jacob et al published their first series on laparoscopic colorectal surgery, laparoscopic and laparoscopic assisted surgery has become a part of surgical training and practice[1]. In 2006, Reza et al in their systematic review comparing the efficacy and safety of laparoscopic colorectal cancer surgery to open surgery concluded that even though laparoscopic colorectal cancer surgery took longer to perform, it offered certain short-term benefits including reduced pain, reduced blood loss, shorter hospital stay and earlier return of gut function[2]. Abraham et al in 2004 performed a meta-analysis of short-term outcomes after laparoscopic colorectal surgery. They analysed 12 RCTs and a total of 2512 surgeries. They found a lower morbidity, less pain, faster recovery, and shorter hospital stay with no adverse outcomes in respect to oncological clearance[3] after laparoscopic colorectal surgery. The cost of laparoscopic colorectal surgery has been of interest to researchers and is important to health authorities with regards to funding. Ridgeway et al performed a case-matched study of patients who underwent laparoscopic resection between July 2005 and February 2006. They investigated the costs of laparoscopic treatment amongst other parameters. They found out that the though the operative cost of laparoscopic colorectal surgery was higher than open surgery, gains made by shorter hospital stay, fewer readmissions and less morbidity significantly offset the high operative costs making laparoscopic colorectal surgery cheaper and more cost effective[4]. In another large study by Vaid et al involving 63,950 cases of which 8.1% were laparoscopic colectomies as compared to 91.9% being

open colectomies, laparoscopic colectomy was associated with less cost even though in this study open colectomy was the preferred operation[6].

There is a learning curve associated with all laparoscopic surgery with laparoscopic colorectal surgery being no different. In an attempt to quantify the learning curve, Miskovic et al conducted a systematic review on the learning curve for colorectal laparoscopic surgery. They included 4852 cases and found that the learning curve ranged from 88-152 cases. 87 cases were required to show decrease in intra operative blood loss, 143 for decrease in complications, 96 for a decrease in operating time and 152 cases to decrease conversion rate[5].

General surgeons are increasingly offering laparoscopic colorectal surgery to patients in view of the obvious short-term benefits. Moloo et al conducted a national survey on the adoption of laparoscopic colorectal surgery by general surgeons in Canada[7]. About half of the general surgeons surveyed offered laparoscopic colorectal surgery but poor reimbursement and lack of operating time were stated as hindrances to performing these procedures. Most of the surveyed surgeons also preferred visits from experienced laparoscopic surgeons to mentor them.

Schlachta et al attempted to define the learning curve for colorectal resections done laparoscopically. They defined an early learning curve as the first 30 cases after which number the operating time, intraoperative complications and conversion rate began to decline[8]. Bennett et al also published their analysis of 1194 laparoscopic assisted colectomies done by 114 surgeons. There was no difference in conversion rate and hospital stay between high volume and low volume surgeons. However, there was a lower intra operative and postoperative complication rate in the high-volume group.[51]

In Australia, Gandy RC and Christophe RB conducted a retrospective review of 75 laparoscopic colectomies performed by one general surgeon. Their primary endpoint was postoperative morbidity and mortality and secondary end points were surgical margins and lymph node harvest[9].

The surgeon in question performed less than 10 laparoscopic colectomies a year. Their series showed no cases of 30 day postoperative mortality, 9.3% morbidity, leak rate of 1.3% and median lymph node harvest of 17. Thus, appropriately trained general surgeons can perform laparoscopic colorectal surgery with comparable short-term results and oncological clearance to high volume colorectal surgeons. Birks et al, in an audit of sixty-nine rural general surgeons in south eastern rural Australia over 12 months, found that a high number of colorectal operations were performed by rural surgeons with results comparable to other Australian studies[10].

The aim of this study is to analyse laparoscopic colorectal surgery performed by a single surgeon in rural Western Australia, comparing our results and outcomes to other Australian and international studies. Results from this study, apart from auditing our practice, will be used to improve delivery of quality up to date laparoscopic colorectal surgery to our rural population and also encourage rural general surgeons who are not performing laparoscopic colorectal resections to consider adding this kind of surgery to their practice.

METHODS

The records of all laparoscopic and laparoscopically assisted colorectal operations attempted or performed by a single surgeon from 2008 to 2014 were retrieved from the hospital database after ethics approval. Data was de-identified and summarised using Microsoft excel and statistical analysis was performed with SPSS software. Demographics including age and sex were recorded. Operation duration times were retrieved from patient notes. Conversion rate from laparoscopic to open procedure, stoma rate and type of surgery were all recorded. Indications for surgery e.g. diverticular disease or malignancy were also recorded. The site of disease e.g. left or right colon was recorded in cancer cases. The splenic flexure was used as the cut off point for left or right-sided cancers. Pathology results were also looked at with regards to the lymph nodes retrieved. Other pathological characteristics of the cancer cases were not analysed, as the aim of the study did not include analysis of pathology results. Post-operative data including length of stay, readmission, surgical complications, medical complications, mortality (30 day) and re operation rates were also analysed. Medical complications included pneumonia, urinary tract infection, and cardiovascular complications including arrhythmias, myocardial infarction and heart failure or any other medical complication that prolonged hospital stay.

Correlation was tested between duration of surgery and hospital stay using Pearson's test and bivariate analysis was tested between duration of surgery and complications using t-test. X2 –test was used to test for association between complications and outcomes of right vs left sided cancers.

Confidence interval of 95% or more was required for significance.

RESULTS

Demographics (Age, *sex*)

Out of 120 patients, 53 (44.2%) were male and 67(55.8%) were female a ratio of 1:1.3. The mean age was 69.26years with a standard deviation of 12. 623.The minimum age was 30 years and maximum age was 91 years. (Table 1)

Length of stay in Hospital (LOS).

LOS was calculated from post-operative day one until the day of discharge. The median hospital stay was 5 days with the minimum stay of 2 days (this patient underwent a laparoscopic right hemi colectomy) and maximum stay of 67 days in a patient who underwent a laparoscopic left hemi colectomy. (table 1)

Duration of surgery (operating time).

Operating time was accurately determined in 98 out of 120 patients. This was the time from commencement of the actual operation (knife to skin) until the last wound closure. This was measured in minutes. The minimum operating time was 54minutes and the maximum was 234 minutes. The mean operating time was 156.68 minutes (*sd 110.4*).

Total lymph node harvest

The total mean lymph node harvest was 14.34 (sd=6.496). The mean lymph node harvest for right-sided cancers was 16.03 and that for left- sided cancers was 12.95. This was statistically significant (p=0.034).

Type of surgery

Laparoscopic/ laparoscopic assisted (lap/lap A) right or extended right hemi colectomy made up 43.3 % (n=52) of cases done with lap/lap A anterior resections made up 29.16% (n=35) of cases. There were 13 (10.8%) low anterior resections and 7(5.8%) ultra-low anterior resections. Five per cent (n=6) of cases were lap/lap A total colectomies whilst 2.5 % (n=3) were laparoscopic assisted A-P resections. Left hemi colectomies comprised 1.65 % (n=2) of cases whilst laparoscopic repair of rectal perforation, and laparoscopic washout of colonic perforation each made up 1.65 % (n=2) of cases (others).

Elective v Emergency

Majority of cases (96%, n=116) were elective cases with emergencies making up 4 % (n=4). The emergency cases included 1 laparoscopic repair of rectal perforation, 1 laparoscopic anterior resection, 1 laparoscopic right hemi colectomy and 1 laparoscopy and washout of a pelvic abscess.

Duration of surgery and length of stay in hospital

Bivariate analysis between the duration of surgery and length of hospital stay showed no relationship between the two variables.

(correlation coeff=0.014, p-value 0.896).

Pathology

Out of 120 cases, 106 were cancer cases and 14 non-cancers. The non-cancer cases included diverticular disease, large tubulovillous adenomas, serrated adenomas and dysplastic adenomas. Non-cancer cases accounted for 11.7% of all cases. A majority of 88.3 % were cancer cases ranging from carcinoma in situ to poorly differentiated adenocarcinoma. Left sided cancers made up 48.3% of cases with right-sided cancers accounting for 40%. The splenic flexure was used to differentiate between left and right-sided cancers with tumours beyond the splenic flexure classified as left sided cancers.

Complications

4 out of 120 patients had anastomotic leak (leak rate of 3.3%). 3 of these were for left sided cancers and 1 was for right sided cancer. Post-operative bleed rate was 2.5% with 3 patients out of 120 developing significant bleeding post –op requiring intervention. One had bleeding from the staple line requiring laparotomy and revision of anastomosis, 1 patient developed large retroperitoneal haematoma, which required aspiration under CT guidance and the third patient had bleed from the splenic flexure requiring colonoscopy and clip application. Wound infection rate was 6.7 % with 8 patients developing clinical signs of superficial wound infection. Five percent (n=6) of patients developed intra-abdominal abscess with 2 of these associated with anastomotic leaks. Post-operative ileus occurred in 9.16 % (n=11) of patients. Thirty-two out of 120 patients (26.7%) developed medical complications.

These medical complications included pneumonia, urinary tract infection, and cardiovascular complications including arrhythmias, myocardial infarction and heart failure. One patient underwent an unplanned splenectomy due to

iatrogenic splenic injury.

Readmission

There were a total of nine readmissions into hospital. Five of these readmissions were for surgically related complications (3.3% readmission rate). Two of these were for intra-abdominal abscesses, 2 for anastomotic leaks and 1 for small bowel obstruction. The other four readmissions were for non-surgically related problems and hence was not included in or readmission rate calculations.

One was for a bleeding gastric ulcer in a patient with known ulcers, 1 admission was under the medical team for arrhythmias, 1 under the medical team for gastroenteritis and 1 under the psychiatric team for self-harm.

Reoperation

Our re-operation rate was 7.5% (n=9). Three of these patients were returned to theatre for anastomotic leaks. One returned to theatre bowel ischaemia, 1 for persistent ileus, 1 for mesenteric infarct, 1 for harmonic scalpel burn which presented as abscess post operatively, 1 for bleeding at the anastomotic site requiring revision of anastomosis and 1 for drainage of perineal abscess following laparoscopic assisted A-P resection.

Conversion to open procedure

The conversion rate from laparoscopic to an open procedure was 5.8% (n=7). Out of these, 3 were converted to open due to tumour invading local structures (one invading duodenum and two invading the abdominal side walls). One was converted to open due to dense adhesions, one due to a thick fatty mesentery in an obese patient making the laparoscopic operation technically difficult, one after a splenic injury to perform a splenectomy and one was converted when the ink spot could not be found.

Stoma rate

The stoma rate was 12.5% with 15 out 120 patients requiring covering ileostomies or end colostomies. This included the original operation and re-operations for complications.

Mortality

The 30-day mortality was 2.5% (n=3). Two of these patients underwent a right hemi colectomy and one an anterior resection and loop ileostomy. One patient died post - operative day 1 from ischaemic bowel. One patient suffered a massive myocardial infarct and died post-operative day four. The third patient died from aspiration pneumonia on post-operative day 8.

Transfer to tertiary centre

One patient was transferred to a tertiary hospital for intensive care support after re-operation for anastomotic leak.

Duration of surgery vs. complications

Bivariate analyses between duration of surgery and complications showed no statistically significant relationship between the operating time and any of the complications.

Duration of surgery and length of hospital stay

There was weak correlation between the operating time and length of hospital stay (r=0.14, p=0.896). This was considered statistically insignificant.

Right sided vs. Left sided cancers

The mean operating time for right sided cancers was 121.74 minutes which was significantly shorter as compared to 199.24 minutes for left sided cancers

(p=002). The mean total lymph node harvest was 16.03 for right sided cancers and 12.95 for left sided cancers (p=0.034). 10.3% (n=6) of left sided cancer patients developed intra-abdominal abscesses as a complication compared to none in right sided cancer group. This was statistically significant (p=0.022).

Bivariate analysis of the complication rates, re-operation rates, unplanned re-admission, hospital stay and early mortality between right sided and left sided cancers showed no significant relationships.

Table 1

	Mean	Median(range)	Number	Percentage
Age	69.26years	-	120	
Sex	-	-	120	
Male	-	-	53	44.2%
Female	-	-	67	55.8%
Length of stay	--	5days (2-67)	120	
RSC	-	5days	48	
LSC	-	5.5days	58	
NC	-	5days	14	
Lymph node yield	14.34	-	106	
RSC	16.03	-	48	
LSC	12.95	-	58	

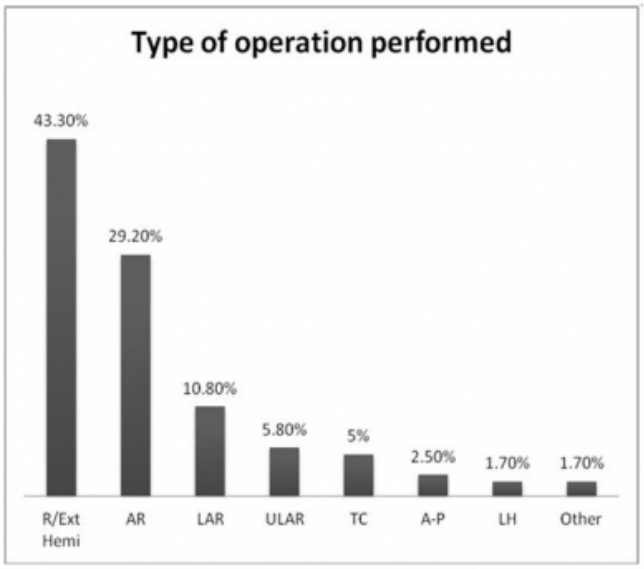
LSC; Left sided cancers, RSC : Right sided cancers, NC : Non cancers

Table 2

	Percentage	Frequency	LSC	RSC
Anastomotic leak	3.3%	4	3	1
Bleeding	2.5%	3	2	1
Wound infection	6.7%	8	5	3
Intra abdominal abscess	5.0%	6	6	0
Re-operation	7.5%	9	-	-
Re-admission	3.3%	5	-	-
Post-operative ileus	9.16%	11	-	-
Medical complications	26.7%	32	-	-

LSC: left sided cancers, RSC: right sided cancers

Figure 1



R/Ext Hemi: Right/extended right hemicolectomy, AR: Anterior resection LAR: Low anterior resection, ULAR; ultra low anterior resection, TC: Total colectomy, A-P: Abdominoperineal resection, LH: Left hemicolectomy LAR: Low anterior resection

DISCUSSION

Laparoscopic surgery is now well established and is a recommended alternative to open surgery for colorectal cancer [11]. With regards to oncological outcomes, laparoscopic surgery is not inferior to open surgery [26]. Age does not appear to be a barrier to laparoscopic or laparoscopic assisted (lap/lap A) colorectal surgery. Laparoscopic surgery has been shown to offer similar benefits irrespective of age. Vingali et al performed a case-matched control study where patients were matched for gender, age, year of surgery, site of cancer, and comorbidity on admission. The patients' independence status on admission and discharge were evaluated. The laparoscopic group had a shorter hospital stay, earlier return of bowel function, and better preservation of independence.[12]. Frasson et al assessed the benefits of laparoscopic surgery in the elderly with respect to functional recovery. Patients were randomised into laparoscopic or open colorectal surgery. They recommended laparoscopic surgery as the first option in elderly patients (>70years) as they had a higher preservation of functional status postoperatively[13]. Stocchi et al, assessing 37 patients undergoing laparoscopic-assisted colectomy and 38 undergoing open colectomy showed that independence status of patients on admission was more frequently maintained at time of discharge in those undergoing laparoscopic-assisted colectomy (95% vs 76%,

respectively, P = 0.025) [14].

In our hospital, which is classified, as an outer regional area by the Australian statistical geography standard [16], our mean age was 69.26 years with a range of 30-91 years. Our average patient will therefore be classified as elderly.

For the regional or rural surgeon in Australia, with an interest in laparoscopic colorectal surgery, a large proportion of surgical colorectal patients will be elderly and this proportion is set to increase[15].

The rural surgeon interested in performing laparoscopic colorectal surgery in Australia must have the support and logistics to deal with an increasing elderly population. In our hospital, there was constant communication with a dedicated colorectal surgeon in the metropolitan hospital who offered advice when needed. All cancer patients were also discussed at multidisciplinary meetings and video link prior to any surgical management. This ensured our patients were not compromised or disadvantaged in any way by having their surgery done in a rural hospital.

Colonic resections for right sided lesions (right hemi colectomy and extended right hemi colectomy) have generally been considered technically easier to perform than resections for left sided lesions(left/extended left hemi colectomy, anterior resection, low/ultralow anterior resection) with a less steep learning curve and fewer cases required to reach proficiency [17]. With regards to cancer cases, right and left sided resections have generally been found to have comparable oncological outcomes but differences have however been reported in surgical site infections, length of hospital stay and operating times [18].

Guillou et al, in the MRC trial, reported a median hospital stay of nine days for successful laparoscopic-assisted excisions. Hospital stay was two days longer for patients who underwent open surgery than for those who had successful laparoscopic surgery[33].

In their study of 4875 colectomies from the American College of Surgeons National Surgical Quality Improvement Program database, Kwaan et al found that laparoscopic right colectomies had a longer hospital stay. Laparoscopic left sided colectomies however had increased re-operation rates for organ space infections. Masoomi et al, analyzing 50,799 elective colectomies for right or left sided cancers from the 2007 Nationwide Inpatient Sample database (9.6% were laparoscopic) found that left sided colectomies for cancer had a higher rate of abscess formation. Alkhamesi et al, conducted a retrospective review of 2,365 segmental colectomies of which 233 were laparoscopically done. They found that left sided colectomies took longer to complete laparoscopically as compared to right sided ones consistent with our findings.

In our series, there was a significant difference in operating times between left and right-sided cancers (p=0.002) with left sided cancers taking longer (mean= 199.24 mins vs 121.74 mins) with a difference of about one hour between the two. This finding was similar in the study by Alkhamesi et al. In a regional or rural setting this difference in the operation times must be taken into account in preoperative planning when booking left sided cases as it may have implications on theatre time allocation, theatre lists and staffing. With regards to intra-abdominal infections, we had a statistically significant difference between left sided and right sided resections (p=0.022). Six patients who underwent left sided resections developed intra-abdominal abscesses.

None of the right sided resections developed organ space abscesses. This relationship between left sided resections and higher intra-abdominal abscess formation was similar to the ACS NSQIP Database study by Kwaan et al and also by Masoomi et al, both very large studies.

Lymph node metastasis is an important prognostic indicator in colorectal cancer and the minimum lymph nodes required for staging is set at 12 nodes [21,22] .

Our mean lymph node harvest of 14.34 nodes meets current oncological requirements for adequate staging of disease.

Our right-sided cancer colectomies yielded statistically more lymph nodes than the left sided cancers (16.03 vs 12.95, p=0.03). We did not analyze or record the approach to ligation of mesenteric vessels e.g. medial to lateral or vice versa. Studies have shown that there are no oncological benefits in choosing one method over the other [41,42,43].

Emergency laparoscopic colorectal surgery is increasingly becoming an acceptable option in colorectal emergencies. Many factors have been known to impede emergency laparoscopic colorectal surgery. These include amongst others, surgeon experience, patient stability and other patient factors like previous surgery, adhesions, bowel distension and local complexity of the disease[45] . Fiaz et analyzed non elective colorectal surgery in the English NHS trusts over an 11-year period. They found that about 1% of emergency colorectal excisions were carried out laparoscopically[44]. Even though the evidence to support the feasibility and

safety of laparoscopic approach in colorectal emergencies is based on non-randomized studies, case series and reports, there is enough data overall to support better outcomes in laparoscopic approach[45]. Four percent (4%) of our procedures were done as emergencies. This was slightly higher than the 1% reported in the large study by Fiaz et al . Two were for partially obstructing cancers, one for laparoscopic repair of rectal perforation and one was for wash out of pelvic abscess.

In a regional /rural setting, emergency laparoscopy colorectal surgery is only feasible in highly selected patients and depends on several factors including logistics, patient factors, surgeon factors and anaesthetic factors.

Though published series have reported similar benefits with elective surgery with respect to hospital stay and recovery times albeit longer operating times [23,24,34,35], our approach was to only perform emergency laparoscopic colectomies in stable patients, during business hours and after team consultation with anesthetists and intensive care.

Decreased hospital stay has consistently been reported as a major benefit of laparoscopic surgery compared to open procedures [27]. Decreased hospital stay also translates to faster recovery and achievement of independence for the patient and has financial benefits to the health system [25]. Publications on the duration of hospital stay after laparoscopic colectomies have reported the lengths of stay from 4.5+/-4 days by Abdulkadir et al, 10.7 +/-0.59 days by Chen et al and 8.72+/-3.72 days by Biondi et al. Our median length of stay was 5 days (mean=7.49 days) with a range of 2- 67 days. This is comparable to other published works. Being a rural area with no other rehabilitation facility, patients who required rehabilitation or recuperation in a step-down facility had to remain in hospital under the bed card of the surgeon until they could be discharged home. This explains and could account for the wide range in our results. The patient who stayed for 67 days had to be in rehabilitation in our hospital.

Our hospital does not have an established ERAS program and application of the principles of ERAS is not uniform across all of our patients. Implementing an ERAS program in the rural setting has its limitations. Lyon et al, identified barriers to implementation of ERAS in their qualitative study conducted in Sydney, Australia[36].

They identified health system resources as one of the main barriers to an ERAS program. Although having an ERAS program in our hospital would further improve short-term benefits, in rural Australia, sparse populations spread over very large areas make it difficult to have an effective ERAS program for rural colorectal patients.

Reported complications after laparoscopic colorectal surgery include superficial and deep wound infections, anastomotic leaks, prolonged ileus, bleeding, intra-abdominal abscesses and medical complications. Veldkamp et al, the COLOR trial group, after analyzing 536 patients who were randomized to their laparoscopic arm , found that 4% had wound infections, 2% had bowel obstruction, 2% had bleeds requiring intervention and 7% were returned to theatre. Their mortality rate was 1% [28]. Schiedeck et al , in their study from five German centres on outcomes of laparoscopic colorectal surgery analyzed 399 patients. They reported a reoperation rate of 9%, mortality of 1.8% and a conversion rate of 6.3% [29]. Barlehner et al in their series on 194 laparoscopically resected rectal cancers had an anastomotic leak rate of 13.5% and conversion rate of 1% [30].

Ng et al from China also published a series of 579 laparoscopically resected rectal cancers. The procedures performed included anterior resections, abdomino- perineal resections, Hartman's procedure and proctocolectomy. They had a conversion rate of 5.4% and anastomotic leak rate of 3.5% [31]. Pugliese et al had a conversion rate of 7.6 % , leak rate of 10.6% and a stoma rate of 35.6% [32]. In our study, our anastomotic leak rate of 3.3% was lower as compared to other international studies (4% CLASSIC TRIAL, 13.5% Barlehner et al, 3.5% Ng et al and 10.6% Pugliese et al)[30,31,32,33.] With the surgeon factor being constant, this could be explained by our careful patient selection for laparoscopic colectomies. Our bleeding rate of 2.5%, re-operation rate of 7.5% and conversion rate of 5.8% were comparable to other published works [29,30,31,32]. The popularity of laparoscopic colorectal surgery has been mainly due to significant short term benefits when compared to open colectomies. Even though 9.16%(n=11) of our patients developed post-operative ileus, only one had to be returned to theatre for suspected obstruction after persistent ileus. No transition point was found and he made an uneventful recovery.

Conversion rate from laparoscopic to open colorectal surgery has been quoted at ranging from 10-14% and has been associated with worse short-term outcomes when compared to operations completed laparoscopically[37,38].

Factors that have been linked to increased risk of conversion from laparoscopic to open surgery include high body mass

index, Americans Society of Anesthesiology score greater than two and low case load/operative experience of the surgeon [38]. Gonzalez et al reviewed 498 cases of colorectal resections between 1997 and 2002. Their study was designed to evaluate the outcomes of conversions compared to laparoscopically completed procedures and open resections37.

They found greater blood loss, longer return of gut function and longer hospital stay in patients whose procedures were converted to open compared to laparoscopic patients. However, converted patients still did better in the aforementioned areas than planned open patients. Pandya et al analyzed 200 laparoscopic colectomies between 1991 and 1998.They divided the patients into cohorts of fifty and studied conversion rates over time[39].

Their overall conversion rate was 23.5% (n=47). The conversion rate was statistically higher in the first quarter than subsequent ones. This highlighted the fact that technical experience and capability of the operating surgeon plays a role in the conversion rate. The more experienced the surgeon, the lower the conversion rate. Analyzing the indications for conversion to open, a large percentage (80%) of conversions were due to either technical problems or technical limitations. They sited amongst others stapler misfire, adhesions, phlegmon, unfavorable body habitus and excessive persistence with technically difficult laparoscopic resection. Our conversion rate was much lower at 5.8%. Three out of our seven conversions were due to tumor invading adjacent structures making laparoscopic resection difficult. These were converted to open procedure in order to achieve an R0 resection.

The usefulness of a covering ileostomy in colorectal surgery is well established. Tan et al, in a meta-analyses of 4 randomized controlled trials and 21 non randomized studies found that a defunctioning ileostomy led to lower clinical anastomotic leak rates and lower reoperation rates46. Chude et al randomized 256 patients who had low anterior resections and stapled anastomosis for low rectal cancers into two groups. Group A had stapled anastomosis without an ileostomy and group B had covering ileostomies after their stapled anastomosis. Twelve patients in group A developed anastomotic leaks with two out of these requiring a Hartman's procedure. There were two deaths in that group. Group B however had 3 anastomotic leaks and no mortality[47]. Covering ileostomy for low rectal cancer resections are beneficial and reduce the severity of anastomotic leaks. The routine use of covering ileostomy for all low or ultra-low rectal resections is debatable.

Lovegrove et al, in their series of 200 patients who had restorative procto-colectomies, selectively used covering ileostomies in 9 patients (5.5%) with good results. The decision to cover the anastomosis with an ileostomy is based on several factors including technically difficult operations, patient factors and the distance of the anastomosis from the anus. In our patients the use of a defunctioning ileostomy was at the discretion of the surgeon. The low and ultra-low resections were more likely to have a defunctioning ileostomy. Also, patients who were immunosuppressed, on steroids or had undergone neoadjuvant radiotherapy had ileostomies. Our low stoma rate, coupled with our low anastomotic leak rate justifies our selective use of ileostomies.

30 day mortality has widely been used as a reflection of patient outcome in the perioperative period. In our series, 3 patients died within 30days of their surgery. Two from cardio-respiratory causes and one from bowel ischaemia.

In a retrospective cross-sectional population-based study of data extracted from the National Cancer Data Repository, Morris et al , after analyzing over 160,000 patients who underwent colorectal surgery between 1998 and 2006 quoted mortality rates between 5.8 and 6.7%.

Their results showed that 30 day mortality increased with age, low socioeconomic status, pre-existing comorbidities, stage of disease and whether the surgery was done as an emergency, with emergent cases having a worse outcome[48]. Shootman et al , in their study in the USA of 47,459 colorectal cancer patients who had undergone surgery found the mortality rate to be 6.6%. They also related high mortality rate with increasing age, high poverty rate, advanced disease, two or more comorbidities and emergency surgery[49].Our mortality rate of 2.5% is comparable to other published studies.

We performed a bivariate analysis of the duration of surgery and complications. We found no statistically significant relationships between the duration of surgery and development of complications. Sheer et al analyzed 487 laparoscopic colonic resections between 1991 and 2005. These included right colonic resections and ileocaecal resections, sigmoid colectomies and total colectomies. They found no effect on the outcomes and complications of segmental colonic resections by increasing operating times. However, longer operating times led to increased

complications in total colectomies.

The major reason for transferring a critically ill patient is provide higher level of care and support. Because the period of transfer may impose risks on the patient, transfer should only be considered if there is going to be some benefit to the patient[50]. One patient from our series was transferred to a tertiary level centre to provide ongoing physiological support after re-operation for clinically significant anastomotic leak.

CONCLUSION

Laparoscopic surgery has become a major part of surgical training and practice and laparoscopic colorectal surgery is increasingly becoming the standard of care. The short-term benefits of laparoscopic colorectal surgery are indisputable and apart from the benefits to patients, the health system also enjoys overall reduction in costs. Rural surgeons in Australia are facing an increasingly ageing population and coming with it an increasing colorectal cancer burden. In Australia, rural surgeons also perform a large number of colorectal resections per year. To access laparoscopic colorectal surgery, rural patients would have to travel long distances to metropolitan areas where most laparoscopic colorectal surgeons practice. This means time spent away from friends and family during recovery periods.

There is a learning curve to performing laparoscopic colorectal resections safely and continuous mentoring by an experienced laparoscopic colorectal surgeon is beneficial. From our study, we have been able to show that in rural Australia, the rural general surgeon can safely perform laparoscopic colorectal surgery with comparable short-term outcomes to dedicated colorectal surgeons. However, we stress that our results could not have been achieved without appropriate patient selection, mentorship from colorectal surgeons in metropolitan hospitals and a dedicated team of rural anesthetists and intensivists. There should also be a system where patients can be discussed in a multidisciplinary setting to include oncologists and radiation oncologist, a setup which exists in our hospital.

We encourage rural surgeons in Australia not offering laparoscopic colorectal surgery to patients to consider up skilling and developing a team in their respective communities as laparoscopic colorectal surgery is here to stay and has become the standard of care in colorectal cancer treatment.

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