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Outcomes of Colectomy and Proctectomy According to Surgeon Training: General vs Colorectal Surgeons

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Brief Title: Colorectal Surgery Outcomes and Surgeon Training

Background: Colectomies and proctectomies are commonly performed by both general surgeons (GS) and colorectal surgeons (CRS). The aim of our study was to examine the outcomes of elective colectomy, urgent colectomy, and elective proctectomy according to surgeon training.

Study Design: Data were obtained from the Vizient database for adults who underwent elective colectomy, urgent colectomy, and elective proctectomy from 2020-2022. Operations performed in the setting of trauma and patients within the database's highest relative expected mortality risk group were excluded. Outcomes were compared according to surgeon's specialty: GS vs. CRS. The primary outcome was in-hospital mortality. The secondary outcome was in-hospital complication rate. Data were analyzed using multivariate logistic regression.

Results: Of 149,516 elective colectomies, 75,711(50.6%) were performed by GS and 73,805(49.4%) by CRS. Compared to elective colectomies performed by CRS, elective colectomies performed by GS had higher rates of complications(4.9% vs. 3.9%, OR1.23, 95%CI 1.17-1.29,p<.01) and mortality(0.5% vs. 0.2%, OR2.06, 95%CI 1.72-2.47,p<.01). Of 71,718 urgent colectomies, 54,680(76.2%) were performed by GS, while 17,038(23.8%) were performed by CRS. Compared to urgent colectomies performed by CRS, urgent colectomies performed by GS were associated with higher rates of complications(12.1% vs. 10.4%, OR1.14, 95%CI 1.08-1.20,p<.01) and mortality (5.1% vs. 2.3%, OR2.08, 95%CI 1.93-2.23,p<.01). Of 43,749 elective proctectomies, 28,458(65.0%) were performed by CRS and 15,291(35.0%) by GS. Compared to proctectomies performed by CRS, those performed by GS were associated with higher rates of complications (5.3% vs. 4.4%, OR1.16, 95%CI 1.06-1.27,p<.01) and mortality(0.3% vs. 0.2%, OR1.49, 95%CI 1.02-2.20,p=.04).

Conclusions: In this nationwide study, colectomies and proctectomies performed by CRS were associated with improved outcomes compared to GS. Hospitals without a CRS on staff should consider prioritizing recruiting CRS specialists.

Keywords: outcomes, general surgeon, colorectal surgeon, colorectal surgery fellowship, colectomy, proctectomy

Abbreviations

GS: General surgeons

CRS: Colorectal surgeons

US: United States

ICD: International Classification of Diseases

CCSR: Clinical Classifications Software Refined

Introduction

The field of general surgery is broad and diverse. With the vastly increasing information and techniques to master within the purview of general surgery, there has been a trend towards sub-specialization amongst general surgery trainees. Colorectal surgery is a popular and growing sub-specialty option for general surgery residency graduates. According to the National Residency Matching Program, colon and rectal surgery training positions have increased from 80 positions at 45 programs in 2010 to 114 positions at 68 programs in 2023(1, 2). As sub-specialization in colorectal surgery has increased, so has the proportion of colon and rectal operations being performed by board-certified colorectal surgeons(3).

There is considerable overlap between the clinical scope of general surgeons (GS) and colorectal surgeons (CRS). According to the Surgical Council on Resident Education, there are several colorectal diseases and operations included in the general surgery core curriculum, which are defined as those "encountered in general surgery for which a graduate of training will possess significant knowledge and be able to provide comprehensive care, including procedural competency"(4). Colon and rectal diseases in the general surgery core curriculum include but are not limited to: colitis, colon and rectal cancer, volvulus, large bowel obstruction, and lower gastrointestinal bleeding(4). Since so many colon and rectal pathologies are included within the core curriculum of general surgery residency, this raises the question: What is the value of pursuing an additional year of training in a colon and rectal surgery fellowship program? There would certainly be value if board-certified CRS produced better outcomes than GS.

While multiple other studies have sought to compare the outcomes after colorectal surgery by GS versus CRS, the existing data is difficult to generalize. An International Cochrane review illustrated that colorectal cancer operations performed by CRS were associated with favorable outcomes, including improved overall five-year survival and improved operative mortality(5).

However, the review included several different countries; and since surgical training requirements vary between different countries, these findings cannot be directly applied to surgical care in the United States (US). Another study found that outcomes after colectomy and proctectomy performed by CRS in New York were better than those performed by GS(6). However, these data are limited to a single state, and therefore cannot be widely applied to the entire US. Thus, this study aimed to determine the outcomes after elective colectomy, urgent colectomy, and elective proctectomy, performed by GS versus CRS at US academic medical centers.

Methods

Data were obtained using the Vizient clinical database, which contains data for all inpatients admitted to US academic medical centers that are members of Vizient, as well as their affiliated hospitals(7). The database reports in-hospital outcomes data for 97% of academic medical centers and 60% of acute care hospitals in the US(7). The data are based on billing records and include demographics, in-hospital mortality rates, and in-hospital complication rates. Data can be selected according to many criteria, including International Classification of Diseases (ICD) procedure codes, principal surgeon specialty, admitting service, patient demographics, admission status (elective or urgent/emergent), and relative expected mortality. The Vizient database uses the Universal Billing Form (UB-04) to determine admission status (categorized as emergent, urgent, elective, newborn, or trauma). The use of this database was approved by Vizient Inc. This study was considered exempt by the Institutional Review Committee at the University of California, Irvine Medical Center because the database does not contain identifiable patient-level data.

Demographic and outcomes data were obtained for all adult inpatients who underwent elective or urgent colectomy [Clinical Classifications Software Refined (CCSR) procedure code GIS009] or elective proctectomy (CCSR procedure code GIS013) from January 1st, 2020 through December 31st, 2022. The data were accessed on May 1st, 2023. Patients were excluded if their relative expected mortality was well above expected and if their operation was performed in the setting of trauma. Patients younger than 18-years-old were also excluded. Demographic information collected included sex, race, and age group (18-30, 31-50, 51-64, 65-79, and ≥80-years-old). The number of institutions where the operations were performed in each group was also reported. Demographic and outcomes data were compared according to principal procedure physician (GS vs. CRS). In the Vizient database, physician specialty is determined by their board certification status. The GS group included surgeons who are board certified in general surgery only. This may include GS who did not receive any fellowship training after residency as well as GS that had additional fellowship training in a subspecialty that does not provide additional board certification, such as minimally invasive surgery. The primary outcome measure was in-hospital mortality. The secondary outcome measure was complication rate, which was defined as: cases with one or more complications divided by total cases. The Vizient database defines cases with complications as those who developed any of the following: stroke, aspiration pneumonia, myocardial infarction, acute kidney injury requiring dialysis, metabolic derangement, respiratory failure, pulmonary embolism, deep vein thrombosis, active Clostridium difficile infection, postoperative infection, urinary tract infection, sepsis, shock, postoperative hemorrhage, hematoma, seroma, wound dehiscence, or readmission. Outcomes after elective colectomy were also analyzed according to sex, race, and age group.

Patient demographics and outcomes were reported by principal procedure physician (GS vs. CRS). Categorical variables were reported as numbers and percentages. Categorical data were compared between groups using Pearson's χ^2 test. In-hospital mortality and complication rates were compared between the two groups using a multivariable logistic regression model adjusting for sex, race, and age group. A P-value of less than 0.05 was considered significant. All analyses were performed using the GraphPad Prism, version 8.0 (GraphPad Inc.).

Results

From 2020 through 2022, 149,516 adults underwent elective colectomy, 71,718 underwent urgent colectomy, and 43,749 underwent elective proctectomy (Figure 1). General and colorectal surgeons performed roughly equal numbers of elective colectomies [75,711 by GS (50.6%) vs. 73,805 by CRS (49.4%)]. General surgeons performed elective colectomies at 828 institutions during the study period (average of 30.5 elective colectomies per institution per year), while CRS performed elective colectomies at only 315 institutions (average of 78.1 per institution per year). General surgeons performed more than three times as many urgent colectomies than CRS [54,680 (76.2%) vs. 17,038 (23.8%)], and only performed about half as many elective proctectomies compared to CRS [15,291 (35.0%) vs. 28,458 (65.0%)]. General surgeons performed urgent colectomies at 857 institutions during the study period (average of 21.3 urgent colectomies per institution per year), while CRS performed urgent colectomies at only 294 institutions (average of 19.3 per institution per year). General surgeons performed elective proctectomies at 478 institutions during the study period (average of 10.7 proctectomies per institution per year), while CRS performed elective proctectomies at only 283 institutions (average of 33.5 per institution per year).

Demographic information is summarized in Table 1. Sex was not significantly different in patients undergoing elective colectomy, urgent colectomy, or elective proctectomy between GS and CRS groups. While the breakdown of race and age groups were statistically different between cases performed by GS versus CRS, overall demographic makeup between groups were similar. The majority of patients undergoing all operations evaluated in this study were white. Most patients undergoing elective and urgent colectomies by GS and CRS were in the 65-79 age group, while most patients undergoing elective proctectomy were in the 51-64 age group (Table 1).

The overall in-hospital mortality rate was 0.4% after elective colectomy, 4.5% after urgent colectomy, and 0.2% after elective proctectomy. After controlling for sex, race, and age group, mortality rate was significantly higher for all operations evaluated when the operation was performed by GS as opposed to CRS (Figure 2). Compared to elective colectomies performed by CRS, elective colectomies performed by GS were associated with higher in-hospital mortality rate (0.5% for GS vs. 0.2% for CRS, OR 2.06, 95% CI 1.72-2.47, $p < .01$). Urgent colectomies were also associated with a higher in-hospital mortality when performed by a GS as compared to those performed by a CRS (5.1% vs. 2.3%, OR 2.08, 95% CI 1.93-2.23, $p < .01$). In-hospital mortality rate also increased when elective proctectomies were performed by a GS as compared to a CRS (0.3% vs. 0.2%, OR 1.49, 95% CI 1.02-2.20, $p = .04$) (Table 2).

A subset analysis demonstrated consistently higher mortality rate after elective colectomy when performed by GS compared to CRS when analyzed according to sex, race, and age group. Figure 3 illustrates that there was a higher mortality rate after elective colectomy performed by GS versus CRS for both sexes (female: 0.5% vs. 0.2%, $p < .01$; male: 0.5% vs 0.3%, $p < .01$); for patients that identified as white (0.5% vs. 0.2%, $p < .01$) and black (0.7% vs. 0.3%, $p < .01$); and

for patients in the 51-64 age group (0.3% vs. 0.1%, $p < .01$), the 65-79 age group (0.7% vs. 0.3%, $p < .01$), and the ≥80 age group (1.4% vs. 0.8%, $p < .01$).

Overall in-hospital complication rate was 4.4% after elective colectomy, 11.7% after urgent colectomy, and 4.7% after elective proctectomy. After controlling for sex, race, and age group, complication rate was significantly higher for all operations evaluated when performed by GS as opposed to CRS. Compared to elective colectomies performed by CRS, elective colectomies performed by GS were associated with a 23% higher complication rate (4.9% for GS vs. 3.9% for CRS, OR 1.23, 95% CI 1.17-1.29, $p < .01$). Urgent colectomies were 14% more likely to result in a complication when performed by a GS as compared to those performed by a CRS (12.1% vs. 10.4%, OR 1.14, 95% CI 1.08-1.20, $p < .01$). Risk of complications increased by 16% when elective proctectomies were performed by a GS as compared to those performed by a CRS (5.3% vs. 4.4%, OR 1.16, 95% CI 1.06-1.27, $p < .01$) (Table 2).

Discussion

This retrospective database study of US adults undergoing elective colectomy, urgent colectomy, and elective proctectomy from 2020 through 2022 demonstrated significantly lower in-hospital mortality and complication rates for CRS as opposed to GS. While GS and CRS performed about equal numbers of elective colectomies, GS performed more than three times as many urgent colectomies than CRS, and CRS performed twice as many elective proctectomies as GS.

One potential explanation for the improved outcomes after colorectal operations were performed by CRS is the well-established positive association between surgeon case volume and surgical outcomes(5, 8, 9). The significantly increased volume of colon and rectal operations performed by board certified CRS may partially explain the improved outcomes when these operations are performed by fellowship-trained sub-specialists. This increased case volume begins in training.

To complete general surgery residency, trainees must perform a minimum of 40 large intestine operations and 20 anorectal operations during their 5 clinical years of training(10). In contrast, colorectal surgery trainees (who have all completed a general surgery residency) complete a minimum of 120 abdominal colon and rectal operations and 60 anorectal operations within only 1 year of training(11). It is not surprising that board certified CRS may have a higher level of expertise than their GS colleagues, given that colorectal trainees are required to perform three times as many colon and rectal operations than general surgery residents, all compressed into 1 year. Our study could not specifically elucidate the case-volume relationship, as the database used does not provide data on the number of unique surgeons performing the operations. While we did find that GS and CRS each performed about half the elective colectomies in our study, there are many more GS than CRS in the US. According to the American Board of Surgery(12), there are currently 31,825 board-certified GS, whereas the American Board of Colorectal Surgery(13) states there are only 2,072 board-certified CRS. Since there are so many more GS than CRS, it is likely that the average CRS in our study performed more elective colectomies than the average GS. Similar to our study, Saraidaridis et al.(6) found that among New York adults undergoing colectomy and proctectomy, that those performed by GS saw double the in-hospital mortality than those performed by CRS. After adjusting for surgeon and hospital volume, they found that these operations performed by GS saw a 32% increase in in-hospital mortality as compared to CRS. They concluded that hospital and surgeon volume accounted for over half (53%) of the reduction of in-hospital mortality of operations performed by board-certified CRS.

In addition to the positive association between surgeon case volume and surgical outcomes, there is also a well-established positive association between hospital case volume and surgical outcomes(5, 8, 14, 15). During the three-year study period, we found that the GS group

performed 75,711 elective colectomies at 828 institutions (average of 30.5 elective colectomies per institution per year), while the CRS group performed 73,805 elective colectomies at only 315 institutions (78.1 elective colectomies per institution per year). Similarly, the GS group performed 15,291 elective proctectomies at 478 institutions (10.7 proctectomies per institution per year), while the CRS group performed 28,458 elective proctectomies at only 283 institutions (33.5 proctectomies by CRS per institution per year). In fact, all operations evaluated were performed at more institutions in the GS group as compared to the CRS group. These data suggest that not all hospitals have a CRS specialist on staff. We also found that the institutions where CRS performed elective colectomies and proctectomies are, on average, higher volume centers than those where GS performed these procedures. This could partially explain the improved outcomes in the CRS group.

Notably, in our study the GS group performed more than 3 times as many emergent colectomies as the CRS group. This finding reflects the fact that GS tend to be the ones that are covering emergency surgical call at most institutions. Despite the vast majority of urgent colectomies being performed by GS, in-hospital mortality rates were significantly higher for urgent colectomies performed by GS compared to CRS (5.1% vs. 2.3%). The same was true for complication rate (12.1% for GS vs. 10.4% for CRS). Other studies have also found that while GS perform more urgent colectomies than CRS, that CRS see improved outcomes. In a New York study of patients undergoing urgent colectomy for acute diverticulitis between 2000 and 2014(16), only 6% of operations were performed by CRS. They similarly found that these operations performed by GS were associated with a higher mortality rate than those performed by CRS (7.5% vs. 5.3%). Another database study of colorectal operations performed in the US between 1992 and 2002 similarly found that only 7.6% of urgent colorectal operations were performed by board-certified CRS, but that this proportion was increasing with time(3). In our

study, we found that 23.8% of urgent colectomies were performed by CRS. While this is still a minority, it is more than the 7.6% of urgent colectomies performed by CRS in the 1992-2002 study by Etzioni et al(3). This may be indicative of the growing proportion of colorectal operations being performed by CRS with the increasing trend towards sub-specialization with time. Interestingly, we found that while GS performed more than 3 times as many urgent colectomies than CRS, GS and CRS performed similar numbers of urgent colectomies per institution per year (21.3 and 19.3, respectively). GS performed urgent colectomies at 857 institutions, while CRS only performed urgent colectomies at 294 institutions. This suggests that many urgent colectomies that are performed by GS may be at institutions that do not have a CRS on staff. Not surprisingly, urgent operations in our study were associated with the highest mortality and complication rates. Urgent operations also had the largest mortality difference between the general and colorectal surgeon groups. Urgent surgical problems often require the most refined skill and judgment to obtain optimal outcomes.

This study has several limitations. As a retrospective database study, there is an inherent selection bias and risk of ICD coding errors. In addition, the database is limited to reporting in-hospital mortality and complication rates only. Therefore, mortality and complication rates may be under-estimated, as our data do not include deaths or complications that occur after discharge. Also, while we were able to control for sex, race, and age group, the database did not provide detailed data on each patient's comorbidities, the indication for each operation, or if each operation was open or minimally invasive. These extra data would have provided a more robust comparison between groups. We did exclude patients if their relative expected mortality was well above expected and if their operation was performed in the setting of trauma in attempt to exclude outliers that would have confounded our results. Also, because the database does not provide data on the number of unique surgeons performing the operations, we were unable to

elucidate the relationship between surgeon case volume and outcomes. Another limitation to this study is the fact that while we know the number of cases with one or more complications, we do not know the type or severity of complications that occurred. This makes it difficult to compare the clinical significance of the different complication rates between comparison groups. This is why our primary outcome was in-hospital mortality rate. Finally, since the Vizient database only includes data about US academic medical centers and their affiliates, our findings may not be generalizable to total surgical care in the US, which also includes independent community hospitals.

Conclusions

There is considerable overlap between the scope of general and colorectal surgeons. There has been an increasing trend towards sub-specialization after general surgery training over time, with one common sub-specialty being colon and rectal surgery. Despite the increasing amount of colon and rectal surgery training positions, we found that CRS and GS performed about an equal number of elective colectomies and GS performed the majority of urgent colectomies. We found that among US adults undergoing elective colectomy, urgent colectomy, and elective proctectomy at academic medical centers and their affiliates from 2020 through 2022, there was significantly lower in-hospital mortality and complication rates for operations performed by CRS as opposed to GS. This study suggests that there is value in specialty colorectal surgery training after general surgery residency. We also found that CRS are performing these operations at a concentrated number of hospitals, suggesting that many institutions are lacking CRS specialists. Hospitals lacking a board-certified CRS specialist may want to consider the implications of these improved outcomes when colon and rectal operations are performed by CRS.

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Figure Legend

Figure 1. Flowchart of the breakdown of operations evaluated during the study period.

Figure 2. Mortality rate for elective colectomy, urgent colectomy, and elective proctectomy for general vs colorectal surgeons.

Figure 3. Mortality rate for elective colectomy for general vs Colorectal surgeons by sex, race, and age group.

Précis

In this retrospective database review, colectomy and proctectomy procedures performed by colorectal surgeons were associated with lower in-hospital mortality and in-hospital complication rates, as opposed to those performed by general surgeons.

Table 1. Demographics of Adults who Underwent Elective Colectomy, Urgent Colectomy, and Elective Proctectomy by General and Colorectal Surgeons

Demographic	Elective colectomy			Urgent colectomy			Elective proctectomy		
	General surgeon n=75,711	Colorectal surgeon n=73,805	p Value	General surgeon n=54,680	Colorectal surgeon n=17,038	p Value	General surgeon n=15,291	Colorectal surgeon n=28,458	p Value
Sex			.3			.7			.8
Female	39,653 (52.4)	38,849 (52.6)		29,371 (53.7)	9,120 (53.5)		7,698 (50.3)	14,290 (50.2)	
Male	36,058 (47.6)	34,956 (47.4)		25,309 (46.3)	7,918 (46.5)		7,593 (49.7)	14,168 (49.8)	
Race			< .01			< .01			< .01
White	65,144 (86.0)	64,296 (87.1)		46,044 (84.2)	14,223 (83.5)		13,344 (87.3)	25,347 (89.1)	
Black	8,788 (11.6)	7,687 (10.4)		7,313 (13.4)	2,435 (14.3)		1,420 (9.3)	2,249 (7.9)	
Asian	1,779 (2.3)	1,822 (2.5)		1,323 (2.4)	380 (2.2)		527 (3.4)	862 (3.0)	
Age group, y			< .01			< .01			< .01
18-30	1,954 (2.6)	3,024 (4.1)		1,962 (3.6)	1,270 (7.5)		500 (3.3)	1,325 (4.7)	

31-50	13,533 (17.9)	14,618 (19.8)		9,416 (17.2)	3,440 (20.2)		3,127 (20.4)	6,580 (23.1)	
51-64	24,901 (32.9)	24,399 (33.1)		16,199 (29.6)	4,764 (28.0)		5,399 (35.3)	9,992 (35.1)	
65-79	28,608 (37.8)	25,837 (35.0)		19,485 (35.6)	5,480 (32.2)		5,223 (34.2)	8,819 (31.0)	
≥80	6,715 (8.9)	5,927 (8.0)		7,618 (13.9)	2,084 (12.2)		1,042 (6.8)	1,742 (6.1)	

Data presented as n (%); p values based on Pearson's χ^2 test

Table 2. Outcomes after Elective Colectomy, Urgent Colectomy, and Elective Proctectomy by General and Colorectal Surgeons

Operation, outcome	General surgeon, n (%)	Colorectal surgeon, n (%)	Odds ratio (95% CI)	p Value
Elective colectomy				
Overall in-hospital mortality	378 (0.5)	168 (0.2)	2.06 (1.72-2.47)	< .01
Cases with complication	3,708 (4.9)	2,880 (3.9)	1.23 (1.17-1.29)	< .01
Urgent colectomy				
Overall in-hospital mortality	2,812 (5.1)	394 (2.3)	2.08 (1.93-2.23)	< .01
Cases with complication	6,607 (12.1)	1,767 (10.4)	1.14 (1.08-1.20)	< .01
Elective proctectomy				
Overall in-hospital mortality	48 (0.3)	56 (0.2)	1.49 (1.02-2.20)	.04
Cases with complication	804 (5.3)	1,264 (4.4)	1.16 (1.06-1.27)	< .01

p Values based on multivariate analysis controlled for sex, race, and age group

CI, confidence interval

Figure 1

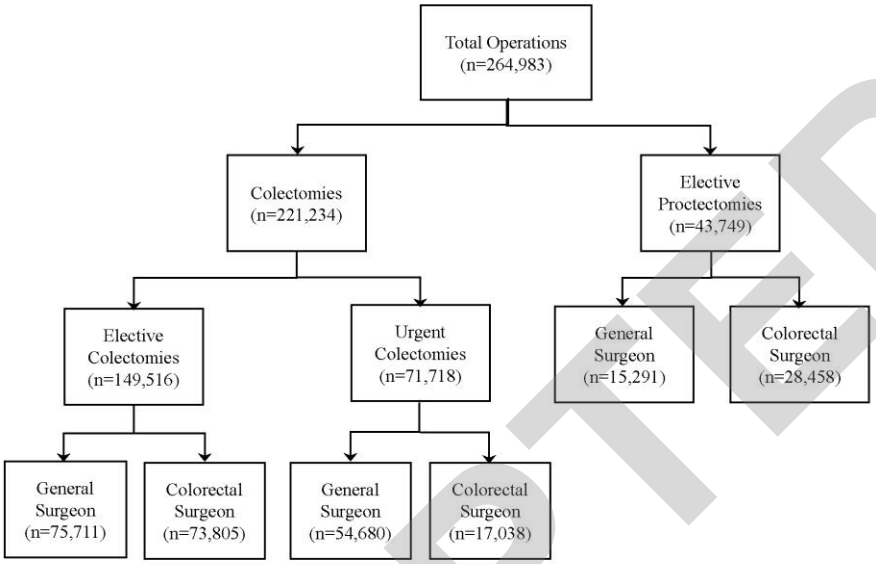

Figure 2

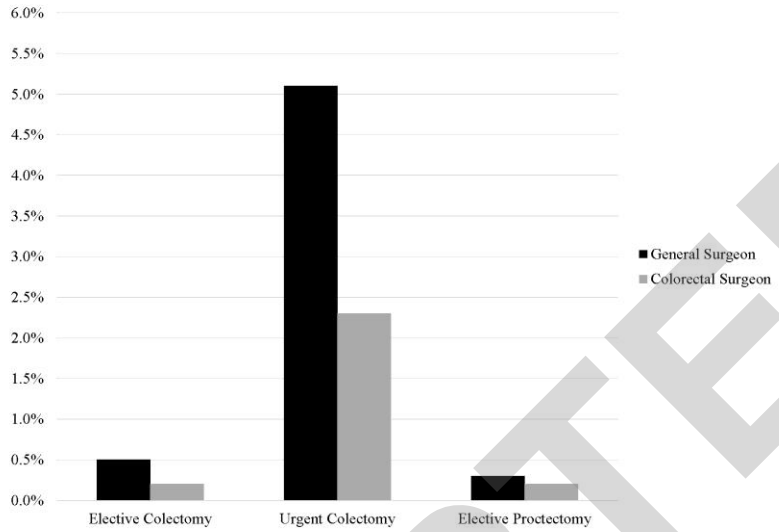

Figure 3