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Lower Anterior Resections for Rectal Cancer– Minimally Invasive Better Than Open in a Non-Academic Setting?

Abstract

Research question: In patients with rectal cancer undergoing lower anterior resections (LAR), are the operative approaches (open versus laparoscopic versus robotic) statistically significant in terms of complications and outcomes? Further, do the outcomes from a large private-practice group compare to data published by large, tertiary care academic institutions?

Background, significance, and rationale for the question: There remains uncertainty as to which surgical approach for lower anterior resections is best suited for rectal cancer. Open and laparoscopic surgical approaches have traditionally been the backbone of surgical treatment for rectal cancer; however, the robot offers a relatively new operative approach that adds more complexity to the situation. Larger academic institutions have often compared two different surgical techniques at a time, and few have compared all three surgical approaches at once. There is an especially notable lack of data related to rectal cancer resections in a community setting.

Materials and Methods: This is a retrospective study from a large group of private-practice colorectal surgeons in a large metropolitan area. A prospectively maintained database was used, and data was queried for low anterior resections using robotic, open, and laparoscopic, approaches in the resection of rectal cancer. Further, data on morbidity and mortality, along with postoperative complications such as acute blood loss anemia, anastomotic leak, and surgical site infection, were evaluated.

Results: From 2016 to January 2020, a total of 130 patients underwent robotic, open, or laparoscopic oncologic lower anterior resections for rectal cancer. Length of stay was noted to be statistically significant ($p<0.005$) when comparing the open (8.08 days), laparoscopic (7.04 days), and robotic (4.96 days) approaches, respectively. When comparing all three surgical approaches, it was determined that there was no statistical significance for estimated blood loss, operating time, or other postoperative complications including pneumonia, ileus, pulmonary embolism, urinary tract infection, surgical site infection, or anastomotic leak. When the two minimally invasive surgical approaches were combined (laparoscopic low anterior resection and robotic low anterior resection) and compared directly with the open surgical approach, both estimated blood loss and length of stay were statistically significant ($p = 0.021$ and $p=0.005$, respectively). There were no perioperative or postoperative mortalities.

Conclusions: This study shows that minimally invasive surgical low anterior resections have a noteworthy advantage over the open approach in terms of length of stay and estimated blood loss. However, it was unexpected, and significant, to note that robotic surgery offered better outcomes when compared to laparoscopic low anterior resections. This experience in the private practice world raises the question as to whether the robotic approach should be considered the standard of care for patients undergoing low anterior resection for rectal cancer.

Research Question:

The goal of this study is to examine the differences between the operative techniques of low anterior resections in a non-university, community-based practice. With that in mind, the specific question for this research study is: in patients undergoing low anterior resections (LAR) for rectal cancer, are the operative approaches (open versus laparoscopic versus robotic) statistically significant in terms of complications and outcomes? Further, does this data, from a large private-practice group, compare to large, tertiary academic institutions?

Specific aims: We intend to compare the operative approaches (robotic vs. open vs. laparoscopic) in all patients with rectal cancer undergoing a low anterior resection between 2016 to 2020. Data on morbidity and mortality, along with postoperative complications such as acute blood loss anemia, anastomotic leak, and surgical site infection, will be evaluated as well.

Hypothesis: The hypothesis is that open surgical cases will have statistically significant longer hospital stays, slower operative times, and greater estimated-blood loss when compared to robotic and laparoscopic low anterior resections of rectal cancer patients in a large, non-academic, community private practice group.

We anticipate that LAR in a community, private practice setting, regardless of the operative approach, will be equivalent, in terms of complications and outcomes, to that of larger academic institutions. This data will offer insight into what most colorectal surgeons are doing in their private practices and may be more indicative of the outcomes that both patients and surgeons can expect in a non-academic, “real-world” setting. Further, despite larger academic settings often seeing more advanced disease for which they are more accustomed to dealing with, we expect that the real-world outcomes will be equivalent.

Introduction, Significance, and Rationale

In both men and women in the United States, the third most common cancer diagnosed is colorectal cancer [1] with an estimated 44,850 new cases of rectal cancer in 2022 [2]. The complicated nature of rectal cancer management and treatment necessitates a multidisciplinary approach with several different treatment modalities available. Communication and teamwork amongst a number of different specialties, not limited to surgical oncology, radiation oncology, and medical oncology, is imperative to determine the best treatment options for the patient. Perioperative chemo-radiotherapy can often augment the possible curative effects of surgical resection. In the last few decades this has led to an increase in the overall survival of rectal cancer from 50% to 75%, and improved prognosis for locally advanced disease with local recurrences decreasing from 40% to less than 10% [3]. Unsurprisingly, the overall survival of patients correlates with the stage of rectal cancer where those with a more advanced disease at presentation have a worse prognosis [4].

The goal for treatment in invasive rectal cancer is the complete removal of the tumor and resection of the lymphovascular system to insure no local spread of disease. This often entails removal of the tumor with a minimum negative proximal margin of 5 cm, distal of 2 cm [5], and radial margin greater than 1 mm. Predictably, surgery is the main treatment option for patients with rectal cancer but the surgical approach differs based on the location of the tumor. The operative approach is dictated based on the site of the tumor relative to the anal sphincter. For mid-proximal tumors, where the anal sphincter can be spared and the anastomosis occurs low in the pelvis, a low anterior resection (LAR) is often the favored surgical approach [6]. Abdominal perineal resection (APR) is the surgical approach when the sphincter is involved in the surgical resection. LAR surgical approaches that are suitable for the management of rectal cancer include laparoscopic, robotic, and open, but there remains uncertainty as to which option provides the greatest outcomes for the patient.

Laparoscopic and open surgical approaches for rectal cancer showed similar perioperative morbidity and mortality in large, multicenter randomized controlled trials. However, the laparoscopic approach demonstrated earlier return to bowel function, less analgesic requirements, less time in the hospital, and decreased operative blood loss [7-10]. When comparing laparoscopic LAR to the traditional, open LAR approach, there appears to be equivalent short-term oncologic outcomes for rectal cancer [11]. Furthermore, long-term outcomes like disease-free survival, locoregional recurrence, and overall survival were also found to be comparable [12-14]. Although there have been great improvements and adaptations in the laparoscopic surgical approach, there are still unique limitations such as the two-dimensional representation of the operative field, limited maneuverability, and imperfect views of the anatomy which may affect the quality of oncological resection in the pelvis [15].

Some inherent disadvantages of laparoscopic surgery were nullified with the implementation of robotic surgery with improved movability and visibility for the surgeon, while also reducing the naturally occurring physiologic tremor that can be seen in open and laparoscopic surgery [16]. In randomized controlled trials of patients with rectal cancer undergoing resection, there were no differences observed in perioperative morbidity, return to bowel function, conversion to open, or quality of oncologic resection when comparing robotic to laparoscopic techniques [17-19]. In one study, the robotic group had less intraoperative blood

loss and a higher mean operative time when compared to a laparoscopic group in LAR for rectal cancer patients [20] while another found that postoperative urinary retention rates were lower with the robotic approach [21]. Robotic surgery was also found to be more expensive when compared to laparoscopic surgery in rectal cancer patients [22]. When comparing the robotic LAR to that of the open LAR for rectal cancer, the robotic surgical approach had less operative blood loss and a smaller dip in hemoglobin postoperatively, while other clinically relevant outcomes were similar, or superior, to the open approach [23].

There remains much debate surrounding the optimal surgical approach for LAR, especially with the introduction of robotic surgical technique for rectal cancer, which further muddies the waters. Studies using the National Cancer Database (NCDB) have investigated the optimum surgical approach for LAR in rectal cancer patients and showed that robotic compared to laparoscopic was associated with a shorter LOS, while also highlighting short-term surgical outcomes that were comparable between robotic and open procedures [24]. Another study using the NCDB database revealed only small differences in hospital length of stay, readmission rates, negative margins, and overall survival when comparing the open approach to minimally invasive (both robotic and laparoscopic) approaches [25]. However, few studies from a single institution have directly assessed the three operative techniques for LAR. Most of these single institutions are also large, tertiary care academic centers, which introduces a certain level of bias as well. Furthermore, there are few, if any, "real-world" studies from a non-university setting that have compared the three surgical approaches for rectal cancer. These non-university settings are arguably the practice type where most rectal cancer resections take place within the United States, and therefore represent what most colorectal surgeons see often in their day-to-day practice.

Therefore, the goal of this study is to assess the differences between LAR surgical approaches in a non-university, community-based practice. Specifically, in patients undergoing low anterior resections (LAR) for rectal cancer, are the operative approaches (open versus laparoscopic versus robotic) statistically significant in terms of complications and outcomes? Further, does this data from a large private-practice group compare to large, tertiary academic institutions? We intend to compare the operative approaches (robotic vs. open vs. laparoscopic) in all patients with rectal cancer undergoing a low anterior resection between 2016 to 2020. We hypothesize that open cases will have statistically significant longer operative times, greater estimated-blood loss, and longer hospital stays when compared to robotic and laparoscopic low anterior resections of rectal cancer patients in a large, non-academic, community private practice group. We also anticipate that LAR in the community setting, regardless of the operative approach, will be equivalent, in terms of complications and outcomes, to that of larger academic institutions. This data offers insight into what most colorectal surgeons are doing in their private practices and may be more indicative of the outcomes that both patients and surgeons can expect in a non-academic setting. Further, despite larger academic settings often seeing more advanced disease, we expect that the real-world outcomes will be equivalent.

We anticipate that this paper could offer valuable insight into the optimum surgical approach for LAR in rectal cancer patients for surgeons not at a large academic institution. By highlighting the safety and equitable surgical outcomes, it could offer evidence that surgeons in private practice are able to use minimally invasive surgical approaches for the resection of

rectal cancer, which would limit complications for patients and result in shorter hospital stays. Perhaps surgeons in the community are more accustomed to using the open surgical approach for rectal cancer, and this study could highlight the efficacy and safety of those minimally invasive techniques. Thus, prompting private practice colorectal surgeons to re-think their operative techniques and use the surgical approach best suited for the patient. This means that patients may spend less time in the hospital while losing less blood and suffering from less complications. Overall, this paper could provide evidence for a colorectal surgeon in the community who may be teetering the line between committing to MIS approaches as opposed to the more customary open approach.

Research Materials and Methods

Study Design

A database from a non-university, tertiary care center spanning from 2016 to 2020 was retrospectively reviewed for patients who underwent low anterior resections for rectal cancer. 15 different surgeons, across multiple facilities, were identified and included. 200 patients were initially identified, but 130 were included. Procedures of a lower anterior resection with primary anastomosis with or without ileostomy creation were included. If a patient's initial operation included other secondary procedure (i.e. splenectomy, ventral hernia repair, or any other significant procedures) they were excluded to minimize confounding variables. Cases that were converted from a minimally invasive surgical approach to open surgery were categorized into the open surgery category. For robotic surgical approaches, the da Vinci Surgical System (Intuitive Surgical, Inc., Sunnyvale, CA, USA) was used. Patient demographics such as sex, body mass index (BMI), and age were collected along with the American Society of Anesthesiology (ASA) scores. Perioperative and postoperative outcomes such as length of stay (LOS), operating room time (ORT), estimated blood loss (EBL), acute blood loss anemia, anastomotic leak, surgical site infection, deep venous thrombosis (DVT), bowel obstruction, ileus, stroke, heart attack, pneumonia, urinary tract infection, and 30-day return ED visit were also collected. Perioperative and postoperative mortalities were also collected. Data was de-identified and stored on my personal laptop using a password encrypted excel file.

Statistical Analysis

For statical analyses, Statistical Product and Service Solutions (SPSS) version 28.0 software (SPSS Inc., IBM, Armonk, NY) was used. Data were presented as median and mean ± standard deviation (SD) and frequency when applicable. To compare numeric groups, student t-test and Analysis of Variance (ANOVA) were used, while categorical variables were evaluated with a χ^2 test. For statistical significance, a P-value of <0.05 was used. Tables were used to compare LAR surgical approaches and different variables such as the demographics and perioperative and postoperative outcomes. Further, an additional table was used to compare the open and minimally invasive (both robotic and laparoscopic) LAR surgical approaches for perioperative and postoperative outcomes. Data that was not statistically significant, such as acute blood loss anemia, anastomotic leak, infections (such as the surgical site, etc.), deep venous thrombosis (DVT), bowel obstruction, ileus, stroke, heart attack, pneumonia, urinary tract infection, and 30-day return ED visit were not included in tables.

Results

Preoperative Demographics and Characteristics

Between 2016 and 2020, a total of 130 lower anterior resections using the three different surgical approaches – open (OLAR), laparoscopic (LLAR), and robotic (RLAR), were performed for rectal cancer resection and included for analysis. The mean age was comparable for all the surgical approaches: 61.2 years for OLAR, 56.73 years for LLAR, and 59.6 years for RLAR, respectively. More males underwent resection, with comparable female percentages across all three surgical approaches (42% for OLAR, 32% for LLAR, and 32% for RLAR.) Body mass index (BMI) and American Society of Anesthesiology (ASA) scores were used to evaluate for operative candidacy. BMI were similar across all three groups (27.51 for OLAR, 25.1 for LLAR, and 26.3 for RLAR). The ASA scores were comparable amongst the three groups and not statistically significant. For all these demographic variables, there was no statistically significant findings across all three groups (Table 1).

Operative and Postoperative Results

For each of the three surgical approaches, factors such as length of stay (LOS), operating room time (ORT), and estimated blood loss (EBL) were analyzed and compared between perioperative and postoperative outcomes. ORT was defined as the time from the beginning of incision to skin closure. EBL was the total estimated blood lost during the operation. LOS was the entire duration the patient was admitted to the hospital to their discharge in days. Statistical significance was only found for LOS ($p=0.004$) when comparing all three surgical approaches (Table 2). Similarly, statistical significance was found for both EBL and LOS (($p = 0.021$ and $p=0.005$ respectively) when the open surgical approach was compared directly with the two minimally invasive surgical (MIS) approaches combined (LLAR and RLAR) (Table 3). Further statistical significance was found for LOS ($p<0.05$) when the laparoscopic approach was compared to the robotic approach. There was no statistical significance in rate of open conversion, and they were the same. Similarly, there was no statistical significance for other adverse outcomes or complications, including anastomotic leak, infection of the surgical site, acute blood loss anemia, deep vein thrombosis, obstruction of the patient's bowel, ileus, cerebrovascular accident, myocardial infarction, pneumonia, urinary tract infection, or 30-day return to the Emergency Department. There were no perioperative or postoperative mortalities.

Below are tables representing the major findings of the study.

		Surgical Approach			
		Open	Laparoscopic	Robotic	
					p-value
Number of Cases		26	25	79	
Age (mean)		61.23± 12.98	56.76 ± 12.58	59.58 ± 11.29	0.358
Gender	Male	15 (58%)	17 (68%)	54 (68%)	0.594
	Female	11 (42%)	8 (32%)	25 (32%)	
ASA	1	0	1	0	0.542
	2	0	0	1	
	3	6	10	24	
	4	19	13	51	
	5	1	1	3	
BMI (mean)		27.51 ± 8.43	25.06 ± 5.41	26.30 ± 7.41	0.499

Table 1 – Demographic Breakdown of each LAR surgical approaches. A p-value of <0.05 was deemed statistically significant [26].

	Surgical Approaches			
	Open	Laparoscopic	Robotic	
Total Number of Cases	26	25	79	p-value
ORT (min) (mean)	214.88 ± 101.48	231.52 ± 59.33	240.52 ± 95.27	0.459
EBL (cc) (mean)	276.00 ± 239.84	111.00 ± 149.46	169.37 ± 432.64	0.269
LOS (days) (mean)	8.08 ± 4.58	7.04 ± 5.31	4.96 ± 3.89	**0.004**
Conversion Rate		3 (10.7%)	6 (7.05%)	0.410
30-day ED Return	6 (23%)	5 (20%)	16 (20%)	0.948

Table 2 – Perioperative and Postoperative Outcomes for all 3 different LAR surgical approaches. ORT = Operating room time (min), EBL = Estimated blood loss (cc), LOS = Length of stays (days). **Bold** terms indicate statistical significance (p-value of <0.05) [26].

	Surgical Approaches		
	Open	MIS	P-value
Total Number of Cases	26	104	
ORT (min) (mean)	214.88 ± 101.48	230.81 ± 94.19	0.235
EBL (cc) (mean)	276.00 ± 239.84	151.19 ± 375.73	**0.021**
LOS (days) (mean)	8.08 ± 4.58	5.43 ± 4.24	**0.005**
30-day ED Return	6	21	0.396

Table 3 – Perioperative and Postoperative Outcomes between open and minimally invasive LAR surgical approaches. ORT = Operating room time (min), EBL = Estimated blood loss (cc), LOS = Length of stays (days). **Bold** terms indicate statistical significance (p-value of <0.05) [26].

Discussion and Innovation

This retrospective study from a large group of private-practice colorectal surgeons in a large metropolitan area suggests that minimally invasive LAR have significant benefit over the open surgical approach in terms of length of stay and estimated blood loss. Further, shorter hospital stays were found when comparing the robotic LAR to that of the laparoscopic LAR. Uniquely, this study compared all three different surgical approaches for rectal cancer patients in a non-academic community setting.

While comparison studies offer unique insight into the direct comparison of two different variables, it is crucial to also consider the setting of the study, and how confounding variables could be involved. Most of the current literature compares two surgical approaches at a time, often open and laparoscopic, or laparoscopic and robotic cases [8,9,12,13]. Yet, there are few studies that have compared all three surgical approaches at the same time, or from a single institution. A notable Canadian study investigating rectal cancer surgical outcomes compared open, laparoscopic, and robotic elective LAR and abdominoperineal resections (APR). When comparing the robotic group to that of laparoscopy or open resections, they found a lower rate of conversion to laparotomy and lower estimated blood loss. Amongst the cohorts, there were comparable complication rates when investigating mean length of stay, 30-day readmission, and 30-day mortality [27]. Although a unique study, there were limitations, the most obvious of which was their sample sizes. The data here differs from the Canadian study in that this data focuses only on LAR and did not include APR. This study offers a unique perspective given the scarcity of data available in the comparison of all three surgical approaches for LAR in rectal cancer, and in a community setting.

Often, comparison studies tend to group several types of rectal cancer surgeries (like the aforementioned Canadian study), which leads to more confounding variables. The most common rectal cancer surgeries (APR and LAR) are often grouped together [27,28]; however, APR and LARs are considerably different surgeries, and grouping these together can lead to flawed conclusions. This is highlighted by the fact that wound complications are very different in the APR post-radiation group where LAR can have wound complication rates of ~7% compared to 16-60% for APR [29-31]. Therefore, to further strengthen the conclusions and outcomes, it is imperative to isolate the type of surgery for rectal cancer patients. This is a major goal, and strength, of this study and a truly unique component. However, there is always some level of variability that should be acknowledged. In this study, multiple surgeons, and facilities, were used which inevitably leads to slight variations in the procedure based on the surgeon's preference. For example, surgeons in this study opted to perform an ileostomy out of extra precaution for the colorectal anastomosis which can lead to differences in perioperative outcomes, like operating room time or estimated blood loss. Despite these differences, the fact that multiple surgeons were involved in this study is a strength as well, as it diminishes the volatility of the dataset since it is not highly dependent on a single surgeon's capabilities.

Additionally, in an attempt to remove further bias, this study only included patients who underwent treatment with the post-Enhanced Recovery After Surgery (ERAS) protocol. Especially in colorectal procedures, this protocol has shown to have quicker recovery and lower complication rates [32]. Having data with both pre and post ERAS protocol enrolled patients

would have led to a multitude of confounding elements and this strict adherence to include only post-ERAS patients likely limited the power of this study.

Lastly, surgical outcomes can also be affected by the hospital setting and therefore must be taken into consideration when evaluating the data. In rectal cancer resection, to the best of our knowledge, there are no studies outside of academic institutions that have compared all three surgical approaches. While its significance may not be intuitively distinct, studies have shown that minimally invasive surgical procedures, including laparoscopy and robotic surgery, are performed relatively more frequently in an academic setting than a community one [28]. Therefore, it would be reasonable to assume that academic settings would have better outcomes when compared to the community setting, which was evident by decreased odds of conversion and decreased odds of 30 and 90-day mortality in one study [28]. Interestingly, another study noted that there was no difference in outcomes following surgery for non-metastatic rectal cancer between academic and community centers after matching for facility procedural volume [33]. Additionally, RLAR patients were more likely to be treated at academic centers, receive neoadjuvant therapy, and have higher T-stage and had a longer time to surgery in another study [34]. Therefore, outcomes in robotic or laparoscopic LAR are likely different in a community setting compared to an academic setting.

According to the current literature on perioperative and postoperative outcomes, minimally invasive procedures are found to have longer OR times, shorter hospital stays, and faster recovery with similar safety and oncologic resection [7-9,35]. Our data mostly aligns with these findings, which is underscored by the lower EBL, and shorter hospital stays for the minimally invasive surgical approaches. While the mean OR time was higher for the MIS procedures, it was not statistically significant in this study. The “minimally invasive” nature of MIS procedures, with smaller incisions and more precise maneuverability, likely led to the smaller blood loss. Similarly, and highlighted by the COLOR2 trial [8], less pain and earlier return of bowel function likely contributed to the shortened hospital stay.

This data is further broken down into laparoscopic versus robotic approaches. RLAR had a shorter hospital stay, but the estimated blood loss was not statistically significant. A 2016 meta-analysis of RLAR compared to LLAR showed that LOS was shortened, but with unremarkable differences in EBL and OR time, which corroborates with our data [36]. Similarly, other studies demonstrated a shorter LOS, less EBL [37], and fewer postoperative complications for robotic when compared to laparoscopic surgery for rectal cancer [38]. We hypothesized that the shortened hospital stay might be due less bowel manipulation and tissue trauma as a result of the high-definition view and better dexterity, which also leads to fewer complications. Also, the robotic platform allows for stabilization of the abdominal wall that potentially translates into less pain and quicker recovery after surgery. However, it is important to note that there was not a statistically significant difference in EBL or postoperative complications between LLAR and RLAR.

Limitations of the Study

R0 resection rates and lymph node harvest are often crucial for complete oncologic resection, and the lack of pathologic data pertaining to these factors is a large drawback to this study. R0 resection and harvesting at least 12 lymph nodes are the hallmark of successful oncologic LAR [8]. Currently in the literature, there is no significant difference in approaches in R0

resection and lymph node harvest. Sadly, due to a lack of data pertaining to lymph node harvest and R0 resection, we were unable to investigate the validity of that statement with this study.

The retrospective nature of this study and the small sample sizes limits the generalizability of this data. While this study is larger than many comparison LAR studies in rectal cancer, the n-value of this data is still small. In order to limit confounding due to secondary procedures, only LAR surgeries were included in the analysis, which ultimately decreased the sample size. An additional limitation of this study includes the variabilities in surgical technique amongst surgeons, some of which preferred to perform ileostomies, which may have impacted OR time and postoperative complication rates. Nonetheless, we believe this study has a much more stringent inclusion criteria when comparing to the current literature.

Future Directions

This study offers the unique insight into the outcomes of a large, private-practice, community based colorectal surgeon's group and the operative outcomes of three different surgical approaches for LAR in patients with rectal cancer. The truly unique aspect of this research study was the comparison of open versus laparoscopic versus robotic LAR in those rectal cancer patients in a non-academic, community setting. We feel as though this data is more indicative of what most colorectal surgeons see in their private practices, and thus offers a unique perspective on the surgical oncologic outcomes for those rectal cancer patients. It further emphasizes that MIS surgical outcomes are equivalent, if not better, than open surgical approaches for rectal cancer and are safe to perform in the community setting.

Future directions of research and exploration, based on this research study, are as follows. We acknowledge that there are inherent limitations and biases within this data, therefore it is reasonable to have other large, private-practice, and urban based colorectal groups conduct similar studies, or internal audits, to evaluate their outcomes for the three surgical approaches. If they also see similar results, then we know that the data is generalizable and validates the conclusions. However, if their data does not agree with what we have found, it further calls into question the optimum surgical approach for rectal cancer patients undergoing surgery in a community-based, urban setting. It is also reasonable to compare outcomes of community based colorectal surgeons in different regions of the United States. This may highlight locoregional differences that can prompt further investigations and studies, which would ultimately lead to better outcomes of patients, not only based on the practice setting of the surgeon, but perhaps also based on their regional ties. This is evident by one study investigating the effect of academic status on outcomes of surgery for rectal cancer which showed that minorities and Medicaid patients were more likely to receive care at an academic center [28]. Further, it would be valuable conduct a replica of this study, but in a rural setting. Again, perhaps regional practices of the colorectal surgeons, or even other variables related to the patient demographics, alter the outcomes in a different setting. This would further endorse or refute the validity of our conclusions if we see similar results across multiple practice settings. Since there is a paucity of data related to the comparison of all three surgical approaches, this study could help stimulate large U.S. based academic centers to conduct a similar study. It would be interesting to see if their data aligns not only with ours, but also that of the Canadian study that was mentioned in the Discussion.

Conclusions

This study showed that MIS LAR have better perioperative and postoperative outcomes in a large, non-academic urban setting. Post-operatively, RLAR has a shorter hospital stay, and appears to be a safe alternative to OLAR and LLAR, further bolstering the advocacy for RLAR over its counterparts. A unique aspect of this study was the comparison of all three operative approaches for LAR in patients with rectal cancer in a setting that is most similar to what physicians' face in the "real world." Often, large tertiary referral medical centers see a diverse patient population which is often sicker than what is typically seen in the community setting, which can skew the results of their publications [39]. Dealing with patients that are often sicker, and perhaps teetering on the edge of survival, has an inherent bias which are not always indicative of the population of patients seen in private practice. Further, the larger medical centers often have more resources with the newest and latest medical devices which are not seen in private practice until much later. Therefore, it would make sense that academic centers have better outcomes and results when comparing newer operative approaches (such as the robotic approach). However, this study solidifies that non-academic, tertiary referral centers perform LAR for rectal cancer with outcomes that are like that of academic centers. It also highlights how community based colorectal surgeons can safely perform MIS LAR when compared to the OLAR. Overall, this means that patients will have shorter LOS and less blood loss when compared to patients who receive the OLAR. This experience in the private practice world raises the question as to whether robotic low anterior resection should be considered the standard of care for patients undergoing low anterior resection for rectal cancer.

Compliance

IRB exemption was granted from the Methodist IRB and was co-validated with the TCU IRB. The Texas Colon and Rectal Surgeon's data is de-identified and therefore is exempt from IRB approval. I have completed all CITI training at this time.

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