ORIGINAL ARTICLE

Outcomes of Robotic versus Laparoscopic versus Open Resection for Rectal Cancer in a Center with a Beginning Robotic Colorectal Surgery Program

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ABSTRACT

Background and Objective. Robotic surgery for rectal malignancies in the Philippines is emerging. Evidence has shown promising results for robot-assisted (R) rectal surgery when compared to the laparoscopic (L) and open (O) approach. This study discussed the clinicopathologic outcomes of the first robotic rectal resections versus laparoscopic and open rectal resections at the Philippine General Hospital (PGH).

Methods. This was a retrospective cohort of 45 consecutive surgical resections for rectal malignancy done at the PGH from March 2019 to October 2019 that compared the outcomes of the first 15 robotic procedures done at the institution versus laparoscopic (n=15) and open (n=15) operations performed during the same time period. One-way ANOVA was done to determine significant differences among variables, while Bonferonni multiple comparison test was done to analyze differences among means.

Results. The 45 patients in the study had a mean age of 56.04 ± 13.45 years. The patients were mostly male (60%). Most of the tumors were located in the low rectum (27/45; 60%). Most of the patients had locally-advanced (at least Stage IIIB) disease (27/45; 60%), and warranted neoadjuvant treatment (41/45; 91.11%). Most patients underwent a sphincter-saving procedure (34/45; 75.56%). All three groups had comparable baseline characteristics. The R-group had the longest operative time (438.07 ± 124.57; p value <0.0001). Blood loss was significantly highest in the R-group (399 ± 133.07 cc; p value - 0.0020) as well, while no statistical difference was observed between the O- and L-groups (p value – 0.75). No conversion to open was noted in the R- and L-groups. Most of the patients had well-differentiated adenocarcinoma (22/45; 48.49%). All patients in the L- and O-groups had an R0 resection There were two R1 resections in the R-group. All patients who underwent an open surgery had a negative circumferential resection margin (CRM); L-group 93.99%, R-group 69.23%. All patients had adequate proximal and distal resection margins. Those who underwent an open surgery had the shortest post-operative length of stay (LOS) (p value – 0.0002). Post-operative ileus (7/45; 15.56%) was the most commonly encountered morbidity, and was seen mostly in the R-group (3/15; 20%). One patient in the R-group underwent a transanal repair of an anastomotic dehiscence and was discharged three days after re-operation. There was no reported mortality.

**Dr. Lopez and Dr. Viray shared first authorship for this manuscript.*

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Conclusion. Our institution with a beginning robotic colorectal surgery program showed promise as its initial outcomes for rectal cancer were compared to the more often-performed open and laparoscopic procedures. The authors expect more favorable clinicopathological outcomes as our staff overcome the prescribed learning curve for robotic surgery.

Keywords: rectal surgery, robotic surgery, laparoscopic surgery, open surgery

INTRODUCTION

As minimally-invasive surgery (MIS) continues to develop and expand, evidence in literature has shown increasing acceptance for robotic rectal surgery (R). There have been reports published showing its superiority when compared to the laparoscopic (L) and open (O) approaches.[1–3] However, the ROLARR study showed that robotic surgery compared to conventional laparoscopic surgery did not significantly reduce the risk of conversion to the open technique, and therefore, may not confer an advantage in rectal cancer resection.[4]

Multiple trials have proven the efficacy and safety of laparoscopic colorectal procedures, with outcomes comparable to open surgery.[4–7] Robotic surgery has been shown to result in decreased blood loss, ileus, hospital length of stay (LOS), and mortality when compared to laparoscopy and open.[8]

Robotic surgery for rectal malignancies in the Philippines is becoming a viable option with the first reported robotic procedure having been performed in 2010. Last March 2019, the Division of Colorectal Surgery at the Philippine General Hospital (PGH) had its first robotic rectal surgery using the *da Vinci*® SI Surgical System platform. The consensus appears that the main advantage of the robot in colorectal surgery is with rectal resections, specifically in the performance of a total mesorectal excision (TME).[9] Rectal surgery is uniquely suited for the robot's strengths as the robot provides improved visualization in the confined area of the pelvis, more articulation of the working arms for improved dissection, and better instrument manipulation compared to laparoscopy.[10]

This study compared the clinicopathologic outcomes of the initial 15 robotic resections done from March 2019 to September 2019, with 15 consecutive cases each of laparoscopic and open surgeries performed during the same time period.

OBJECTIVES

General Objective

The study aims to compare the clinicopathologic outcomes of robotic, laparoscopic, and open rectal resections for cancer at the Philippine General Hospital done by the Division of Colorectal Surgery.

Specific Objectives

Specifically, the study aims to describe and compare the following:

1. Clinical and demographic profile of patients who underwent rectal resections from March to October 2019
   a. Age
   b. Sex
   c. Clinical cancer staging
   d. Rectal mass level
2. Intraoperative parameters
   a. Operative times (docking, console, total operative time)
   b. Conversion rate
   c. Hospital length of stay
3. Post-operative clinical and pathologic parameters
   a. Perioperative complications
   b. 30-day morbidity
   c. 30-day mortality
   d. Quality of TME specimen (gross and pathologic)
   e. R0 resection rate
   f. Circumferential resection margin positivity
   g. Lymph node harvest

METHODS

This was a retrospective cohort study to compare the initial cases of robotic rectal resections with conventional laparoscopic and open surgeries for curative treatment of rectal cancer. These cases were done at the PGH from March 2019 to October 2019 under the Division of Colorectal Surgery using the *da Vinci*® SI Surgical System. Ethical institutional review was obtained from the University of the Philippines Manila Research Ethics Board (UPM REB) (2021-508-01). The study was conducted from October 2019 to April 2020. The study was limited to the accrual of the first 15 consecutive robotic rectal resections done at the PGH which was arbitrarily determined by the authors.

The primary surgeons (HM and ML) underwent a structured accreditation with the *da Vinci*® Surgery Technology Training Pathway that included online modules with written examinations, simulation training, case observation, and preceptorship from international experts on robotic colorectal surgery. Dr. Vincent Obias of George Washington University assisted in the team's first cases. Dr. Seon-Hahn Kim of Korea University Hospital joined them remotely in some cases.

Data from the Integrated Surgical Information System (ISIS), the computerized database of the Department of Surgery, was extracted to identify the patients who underwent rectal surgeries within the identified time period. The investigators also reviewed a prospectively-maintained robotic database of the Division of Colorectal Surgery. Pathologic outcomes were gathered from the histopathologic reports issued by the Surgical Pathology Unit of the Department of Laboratories.

All patients were presented at the weekly multidisciplinary team (MDT) meeting of the UP-PGH Colorectal Cancer and Polyp Study Group. After obtaining all necessary diagnostic examinations [i.e., colonoscopy with biopsy; abdominal and chest computed tomography (CT) scan; carcinoembryonic antigen (CEA); pelvic magnetic resonance imaging (MRI) or endorectal ultrasonography (ERUS)], neoadjuvant therapy was commenced, when warranted. Once patients were scheduled for surgery, they were enrolled to an Enhanced Recovery After Surgery (ERAS) program. The patients who were amenable for laparoscopic rectal surgery (resectable, non-bulky, T3 and below, with no significant co-morbidities) formed the pool from which those who were to undergo robotic resection were chosen. Open rectal surgeries were often reserved for trainees, or for tumors that remained locally-advanced even after neoadjuvant chemoradiotherapy.

The Division's standardized techniques in managing its rectal malignancy cases in anastomosis included using stapling method in anterior resection (AR) and low anterior resection (LAR) while handsewn coloanal technique for abdomino-transanal resection (ATAR) cases. All patients that will undergo neoadjuvant radiation will have a protecting stoma.

As a post-operative practice in the Division, patients were asked to follow-up after 7 days and 30 days post-surgery or post-discharge for physical examination of the wound and other possible surgery-related complications.

Descriptive statistics with frequencies, percentages, variabilities (range, standard deviation) and measure of central tendency were utilized to interpret trends across variables. One-way Analysis of Variance (ANOVA) was used to determine statistically significant difference among the three groups, and Bonferroni post-hoc comparison to note differences between groups with significant F-statistics findings. A p value <0.05 was considered significant.

RESULTS

Demographics (Table1)

Forty-five patients were included in the study. The patients were mostly male (60%), with a mean age of 56 years. Most of the tumors were located in the low rectum (60%). Majority (60%) were locally-advanced, or at least Stage IIIB, warranting neoadjuvant treatment. Thirty-six patients (80%) underwent long-course chemoradiotherapy (LCCRT), while five patients (11%) had short-course radiotherapy

Table 1. Demographics of Patients who Underwent Rectal Cancer Surgery

Demographic Parameter	R (n=15)	L (n=15)	O (n=15)	*p*-value
Sex				0.1430
Male	8 (53.33%)	7 (47.67%)	12 (80.00%)	
Female	7 (47.67%)	8 (53.67%)	3 (20.00%)	
Age				0.0538
Mean 56.04	Mean 54.73	Mean 58.00	Mean 55.40	
Range 19-81	Range 37-76	Range 26-75	Range 19-81	
SD ± 13.45	SD ±10.08	SD ±14.79	SD ±15.49	
Distance from the anal verge				0.1700
Low rectal (0-5 cms)	11 (73.33%)	8 (53.33%)	8 (53.33%)	
Mid rectal (6-10 cms)	4 (26.67%)	7 (46.67%)	5 (33.33%)	
High rectal (11-12 cms)	0 (0%)	0 (0%)	2 (13.33%)	
Cancer Staging				0.0600
I (T2N0M0)	0 (0%)	2 (13.33%)	2 (13.33%)	
IIA (T3N0M0)	2 (13.33%)	6 (40.00%)	6 (40.00%)	
IIIB (T3N1M0)	13 (86.67%)	6 (40.00%)	4 (20.00%)	
IIIC (T3N2M0)	0 (0%)	1 (6.67%)	1 (6.67%)	
IV (T3N1M1)	0 (0%)	0 (0%)	2 (13.33%)	
Neoadjuvant treatment				0.1600
LCCRT	11 (73.33%)	11 (73.33%)	14 (93.33%)	
SCRT	2 (13.33%)	2 (13.33%)	1 (6.67%)	
None	2 (13.33%)	2 (13.33%)	0 (0%)	
Procedure				0.6500
AR	0 (0%)	2 (13.33%)	3 (20.00%)	
LAR	6 (40.00%)	10 (66.67%)	6 (40.00%)	
ATAR	4 (26.67%)	0 (0%)	2 (13.33%)	
APR	4 (26.67%)	3 (20.00%)	4 (26.67%)	
Total proctocolectomy	1 (6.67%)	0 (0%)	0 (0%)	

R – robot-assisted rectal surgery; L – laparoscopic surgery; O – open surgery; LCCRT – long-course chemoradiotherapy; SCRT – short-course radiotherapy; AR – anterior resection; LAR – low anterior resection; ATAR – abdominotransanal resection; APR – abdominoperineal resection

(SCRT). The operative plans were mostly sphincter-preserving operations (76%), with (LAR) as the most commonly performed procedure (49%). Abdominoperineal resection (APR) was done in 11 patients (24%) due to the involvement of the external sphincters, perianal skin, and/or puborectalis. One had total proctocolectomy for familial adenomatous polyposis (FAP) with malignant degeneration. The baseline characteristics of the patients in the three groups were comparable.

Intraoperative Parameters (Table 2)

For the R group, the mean positioning time of the patient was 17.25 ± 8.08 minutes, and the docking time was 13.13 ± 5.87 minutes. The mean console time of the surgeon was 233.47 ± 94.44 minutes.

The R group had the longest total operative time (438.07 ± 124.57 minutes; p-value <0.0001) followed by the L group (217 ± 36.14 minutes; p-value <0.0001). Blood loss was also significantly highest in the R group (399.2 ± 133.07cc; p-value 0.0020). No conversion to open surgery was reported in both the R and L groups.

Pathologic Outcomes (Table 3)

Histopathology report of all patients revealed adenocarcinoma, with the well-differentiated type (49%) as the most common finding. R0 resection was noted in all patients who underwent open and laparoscopic surgeries, while two patients (13%) in the robotic group had an R1 resection.

All patients who underwent open surgeries had negative circumferential resection margins (CRM). Positive CRM were noted in the L (7%) and R (31%) groups. Proximal margin was significantly longest in the R group (11.10 ± 4.77 cm; p-value 0.0002), while distal margin was comparable among the three groups (p-value 0.0819).

Lymph node harvest was lowest in the R group (p-value <0.001). Among all the patients included, positive lymph node harvest was not significantly different among the groups (p-value 0.8844). The presence of lymphovascular invasion was mostly observed in the L group (80%; p-value 0.0010). Perineural invasion was not commonly seen in any of the three groups.

Clinical Outcomes (Table 4)

Open surgeries had significantly the shortest length of hospital stay (7.20 ± 2.40 days; p-value 0.0002) and the shortest length of post-operative stay (3.87 ± 1.85 days; p value 0.0002). No significant difference was observed in both the L and R groups.

The overall 30-day post-operative morbidity rate was 22%. Ileus was the most common complication (R – 20% vs. L – 13% vs. O – 13%). All affected patients were managed conservatively. One patient in the R group had an anastomotic leak, warranting a reoperation. He underwent trans-anal repair of the anastomotic dehiscence, and was discharged after three days.

Table 2. Intraoperative Parameters of Patients who Underwent Rectal Cancer Surgery

Intraoperative Parameters	R (n=15)	L (n=15)	O (n=15)	*p*-value
Positioning time (mins)	Mean 17.25 Range 2-28 SD ±8.08	NA	NA	-
Docking time (mins)	Mean 13.13 Range 6-25 SD ±5.87	NA	NA	-
Console time (mins)	Mean 233.47 Range 83-400 SD ±94.44	NA	NA	-
Total operative time (mins)	Mean 438.07 Range 238-650 SD ±124.57	Mean 217.00 Range 175-300 SD ±36.14	Mean 151.33 Range 100-350 SD ±52.12	<0.0001
	Bonferroni multiple comparison L > O (p-value <0.001) R > O (p-value <0.001) R > L (p-value <0.002)			
Blood loss (cc)	Mean 399.2 Range 200-585 SD ±133.07	Mean 216 Range 150-250 SD ±32.47	Mean 221.33 Range 100-250 SD ±63.68	0.0020
	Bonferroni multiple comparison R > O (p-value <0.001) R > L (p-value <0.001) L vs O (p-value 0.75)			
Conversion rate	0 (0%)	0 (0%)	NA	-

R – robot-assisted rectal surgery; L – laparoscopic surgery; O – open surgery

On follow-up at post-operative day 30, a patient was seen with peristomal irritation. Instructions on stoma care were reinforced. There was no reported mortality within 30 days post-operatively. No P-values and significance were places in the 30-day morbidity because the authors just reported the occurrence (by frequency) of the morbidity vis-a vis the rectal surgery approach. Determining the p-value or significant difference among and between the procedures would be non-contributory to the article since the sampling size is only limited to only 45 total patients. The authors acknowledged that increasing the number of the cohort would yield a more compelling statistical computation and conclusive result.

Table 3. Histopathologic Parameters of Patients who Underwent Rectal Cancer Surgery

Histopathologic Parameters	R (n=15)	L (n=15)	O (n=15)	*p*-value
Histology				
Adenocarcinoma	15 (100%)	15 (100%)	15 (100%)	-
Well-differentiated	8 (53.33%)	7 (46.67%)	7 (46.67%)	-
Moderately differentiated	5 (33.33%)	8 (53.33%)	7 (46.67%)	-
Poorly differentiated	2 (13.33%)	0 (0%)	1 (6.67%)	-
Resection margin				0.1230
R0	13 (86.67%)	15 (100%)	15 (100%)	
R1	2 (13.33%)	0 (0%)	0 (0%)	
R2	0 (0%)	0 (0%)	0 (0%)	
Circumferential resection margin				0.0310
Positive (Less than 1 mm)	4 (30.77%)	1 (6.67%)	0 (0%)	
Negative	9 (69.23%)	14 (93.33%)	15 (100%)	
Undetermined/Not reported	2 (13.33%)	0 (0%)	0 (0%)	
Proximal resection margin (cm)	Mean 11.10 Range 2-16.5 SD ±4.77	Mean 6.73 Range 3.5-11 SD ±2.84	Mean 5.37 Range 2.5-11 SD ±2.70	0.0002
	Bonferroni multiple comparison R > O (p-value <0.001) R > L (p-value 0.005) L vs O (p-value 0.06)			
Distal resection margin (cm)	Mean 2.45 Range 0.1-5 SD ±1.78	Mean 2.55 Range 0-8 SD ±1.93	Mean 3.87 Range 1-7.5 SD ±1.78	0.0819
Lymph node harvest	Mean 11.40 Range 3-20 SD ±4.40	Mean 15.20 Range 3-27 SD ±7.27	Mean 16.93 Range 2-34 SD ±10.65	0.01
	Bonferroni multiple comparison O vs L (p-value 0.07) L > R (p-value <0.001) O > R (p-value <0.001)			
Positive lymph node harvest	Mean 9.21% Range 0%-50% SD ±15.85%	Mean 9.15% Range 0%-77% SD ±20.27%	Mean 7.93% Range 0%-33% SD ±12.17%	0.8844
Perineural invasion				0.5660
Yes	2 (15.38%)	1 (6.67%)	3 (20.00%)	
No	11 (73.33%)	14 (93.33%)	12 (80.00%)	
Undetermined	2 (13.33%)	0 (0%)	0 (0%)	
Lymphovascular invasion				0.0010
Yes	3 (23.08%)	12 (80.00%)	10 (66.67%)	
No	10 (76.92%)	3 (20.00%)	5 (33.33%)	
Undetermined	2 (13.33%)	0 (0%)	0 (0%)	
	Bonferroni multiple comparison L > R (p-value <0.0010) O > R (p-value <0.0020) L vs O (p-value – 0.09)			

R – robot-assisted rectal surgery; L – laparoscopic surgery; O – open surgery

Table 4. Short-term Clinical Parameters of Patients who Underwent Rectal Cancer Surgery

Clinical Parameter	R (n=15)	L (n=15)	O (n=15)	*p*-value
Length of stay (days)	Mean 9.53 Range 4-18 SD ±3.42	Mean 10.00 Range 5-19 SD ±3.48	Mean 7.20 Range 5-13 SD ±2.40	0.0002
	Bonferroni multiple comparison R > O (p-value 0.04) L > O (p-value 0.017) R vs L (p-value 0.81)			
Post-operative length of stay (days)	Mean 6.80 Range 3-16 SD ±3.26	Mean 7.67 Range 3-18 SD ±3.60	Mean 3.87 Range 5-8 SD ±1.85	0.0225
	Bonferroni multiple comparison R > O (p-value 0.01) L > O (p-value 0.0015) R vs L (p-value 0.71)			
Post-operative morbidity (30 days)				
Clavien-Dindo Classification Grade I Ileus	3 (20.00%)	2 (13.33%)	2 (13.33%)	-
Clavien-Dindo Classification Grade II UTI	1 (6.67%)	0 (0%)	1 (6.67%)	-
Clavien-Dindo Classification Grade IIIB Leak	1 (6.67%)	0 (0%)	0 (0%)	-
None	10 (66.67%)	13 (86.67%)	11 (73.33%)	-
Reoperation rate	1/15 (6.67%)	0 (0%)	0 (0%)	-
Post-operative mortality (30 days)	0 (0%)	0 (0%)	0 (0%)	-

R – robot-assisted rectal surgery; L – laparoscopic surgery; O – open surgery

Clavien – Dindo Classification of Surgical Complications[11]

Grade I — *Any deviation from normal post-operative course without the need for pharmacological treatment or surgical, endoscopic, and radiological interventions. Allowed therapeutic regimens are: drugs as antiemetics, antipyretics, analgesics, diuretics, electrolytes, and physiotherapy. This grade also includes wound infections opened at the bedside.*

Grade II — *Requiring pharmacological treatment with drugs other than such allowed for grade I complications. Blood transfusions and total parenteral nutrition are also included.*

Grade III — *Requiring surgical, endoscopic, or radiological intervention.*

Grade IIIA — *Intervention not under general anesthesia.*

Grade IIIB — *Intervention under general anesthesia.*

DISCUSSION

Comparison among surgical modalities in oncologic rectal surgery has been studied to determine the efficacy and safety of novel MIS approaches (L and R) versus open surgeries.[8] The open approach has traditionally been the measure of entry-level competence for trainees. Particularly in the Philippines, most surgeons maintain a practice that mostly involves open surgical operations. Minimally-invasive surgery, beyond cholecystectomy and appendectomy, in the country persists to be regarded as an advanced field reserved not only for those with further training, but for those whose institution has the means.

The limitations of open surgery (i.e., limited dexterity, prone to tremor and fatigue, poor exposure in tight spaces) provided an avenue for the development of laparoscopy, which eventually showed acceptable safety and efficacy.[12] Robotic surgery, on the other hand, has been promoted as an alternative to standard laparoscopy due to additional inherent advantages (i.e., three-dimensional views, stable camera control, more precise dissection, reduced tremor and fatigue, and wristed instruments that provide better dexterity in narrow spaces, like the pelvis).[13] Our study compared the outcomes of robotic surgery, early in the learning curve, to laparoscopic and open surgery done by the Division of Colorectal Surgery at PGH.

In our institution (and for a good majority of other hospitals in the country), most rectal cancer patients seek initial consult at an advanced stage of the disease.[14] This is due to lack of access to health care, poor understanding of the disease, absence of a national screening program, and financial constraints.[15] As reflected from these local studies, demographics of our patients were predominantly male with locally-advanced tumors (at least Stage IIIB) located in the mid- to low rectum needing neoadjuvant treatment. Sphincter-preserving surgeries were mostly done except for some patients who underwent an APR for involvement of the external sphincter, puborectalis and/or perianal skin.

The advantages of robotic surgery in dissecting tumors in difficult spaces, such as in a narrow male pelvis, carried moderate evidence from the subgroup analysis of the ROLARR study.[16]

The distribution of these patients in the R group might have had afforded the surgeon better ease during surgery. Our initial robotic experience study revealed patient selection challenges in a surgical training program where the "easier" cases are decked for open approach by the general surgery residents.[17] This is reflected on the distribution of AR and LAR procedures (with less advanced cancer staging) that were mostly done in the L and O groups. The surgeons of the non-robotic procedures were done by senior general surgery trainees and colorectal surgery fellows which were all assisted by a colorectal surgery consultant.

The total operative time was longer in the MIS approaches, particularly the R group. Studies revealed longer operative time in R compared to L.[18,19] Open surgeries were on the other hand had shorter operative time compared to L.[4,20] Blood loss was highest in R group while the L and O groups had no significant difference between them. Multiple studies revealed that MIS approaches had an advantage on decreasing blood loss.[18,20–22] This can be attributed, again, to the early learning curve of the surgeons in the R group. The true learning curve for robotic surgery is achieved after 15-25 cases with an additional 35 more cases for plateau and mastery phases.[23] Furthermore, recommendations for initial robot dissection should begin with a female patient with less advanced tumors located in the high and mid rectum[23] which were more apparent characteristics of the L group. The L and O group may not vary in blood loss due to the higher competency of fellows and consultants in doing laparoscopic surgeries and better assistance of consultants and fellows to resident trainees doing the open surgeries. Learning curve improvement was observed upon subset analysis of a downward trend of intraoperative parameters (positioning time, console time, total operative time, and blood loss) of the R group.[17] No conversion to open was noted in the MIS approaches.

The histopathologic parameters were compared among the groups. The MRC CLASSIC[4], 2010[20] and 2014[6] COREAN Trials revealed no difference in the CRM, completion of total mesorectal excision (TME), lymph node harvest, and resection margins between laparoscopic and open approaches to rectal cancer. These studies were reflected in the outcomes of our study. All the patients in the L and O groups had R0 resection. No significance was noted in total lymph node harvest and proximal margin between O and L. All patients in O had negative CRM. A case of LAR in the L group had positive CRM due to difficulty in dissecting a bulky tumor with poor response to neoadjuvant therapy.

Studies showed no significant difference in TME and resection margins when R is compared to L and O.[24,25] However, the studies of Somashekhar et al. *(p value <0.002)*[22] and Baik et al. *(p value – 0.033)*[26], revealed significant advantage for TME done using the robotic approach that may be attributed to the robot's wristed instruments in a narrow surgical field. The R group had two R1 resections and a negative CRM rate of 69.23%. This advantage of the robotic dissection was not appreciated in our study due to challenges in patient selection and early learning curve of the surgeons.[17] Subset analysis revealed that these patients presented with bulky tumors with poor response to neoadjuvant therapy.

Distal resection margin and positive lymph node harvest had no significant differences among the groups. Oncologic safety, cannot be concluded in the R group due to the limitations of the study. Furthermore, the authors limited the discussion only to the clinical CRM. Pathologic CRM determination was not included in this study, however, the authors projected a low concordance rate between the clinical and pathologic CRMs.

Short-term clinical outcomes were noted to be better in robotic surgery due to its lower conversion rate.[21] While there were no conversions observed in both the MIS approaches, our study showed no difference in post-operative length of stay between the R and L groups. This supported the results of the ROLARR study.[16] The COREAN 2010[20] trial revealed the L group had no significant difference in length of stay *(P value – 0.056)* compared to the O group given that L had shorter time of return of bowel function, and decrease use of pain medications (morphine). However, in our study, the O group had significant shorter length of stay compared to the MIS approaches. Two outliers were noted. First is the LAR patient in the L group who had a prolonged post-operative ileus causing the patient to stay for 18 days after surgery. Second is a robotic surgery patient who had a post-operative leak (14th post-operative day) warranting reoperation. On re-operation, there was a 3 cm anastomotic dehiscence at the left lateral portion with approximately 300 cc of hematoma and feculent substance. The patient underwent a transanal repair and was discharged after three days. Minor 30-day morbidities were noted across the groups which were managed conservatively. No mortality was noted.

This initial comparison of the R, L and O approaches to rectal cancer at PGH provided promising information in the development of a beginning robotic colorectal program. The challenges in patient selection for MIS approaches also reflect overarching challenges of a Filipino rectal cancer patient. As we accrue more cases with longer follow ups, we may be able to standardize MIS training and protocols which will eventually improve our outcomes.

Limitations

This study was limited to a single center with a beginning robotic colorectal program. This study only included the initial 15 robotic rectal surgery cases done by 2 colorectal surgeons in the early phase of learning curve while the laparoscopic and open approaches were done by various surgeons with different rectal surgery competencies. A case-match study with propensity score matching of R, L and O approaches is recommended to decrease selection bias. A long term and randomized study may provide conclusive evidences in efficacy and oncologic safety of novel MIS approaches to rectal cancer in the Philippines.

The clinicopathologic outcomes of these robotic resections were compared to the laparoscopic and open rectal resection done during the same period of the initial robotic rectal procedures. The authors acknowledged possible confounders pertaining to biases that might not be addressed with matching. The authors intended to compare the outcomes to procedures done within the time period mentioned.

The authors acknowledged the confounding effect of having the easier cases decked to open surgery which might possibly affect the results. However, this limitation might be inherent to a setting of a beginning robotic colorectal program which is also a center that is a proponent in colorectal surgery training. Patient safety and colorectal surgery training are facets to be considered as unique to the setting of the center, hence the limitations in addressing expected confounders in patient selection and matching.

The cost-effectiveness of each modality was not discussed in this research. However, the researchers highly recommended a study to explore the comparative cost among the modalities as deemed more equitable for ordinary Filipinos.

CONCLUSION

Our institution with a beginning robotic colorectal surgery program showed promise as its initial outcomes for rectal cancer were compared to the more often-performed open and laparoscopic procedures. The authors expect more favorable clinicopathological outcomes as our staff overcome the prescribed learning curve for robotic surgery.

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Statement of Authorship

All authors certified fulfillment of ICMJE authorship criteria.

Author Disclosure

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REFERENCES

1. de'Angelis N, Alghamdi S, Renda A, Azoulay D, Brunetti F. Initial experience of robotic versus laparoscopic colectomy for transverse colon cancer: a matched case-control study. World J Surg Oncol. 2015 Oct;13:295. doi:10.1186/s12957-015-0708-1. PMID: 26452727; PMCID: PMC4598969.
2. Araujo SEA, Seid VE, Klajner S. Robotic surgery for rectal cancer: current immediate clinical and oncological outcomes. World J Gastroenterol. 2014 Oct;20(39):14359-70. doi:10.3748/wjg.v20.i39.14359. PMID: 25339823; PMCID: PMC4202365.
3. Lin S, Jiang HG, Chen ZH, Zhou SY, Liu XS, Yu JR. Meta-analysis of robotic and laparoscopic surgery for treatment of rectal cancer. World J Gastroenterol. 2011 Dec;17(47):5214-20. doi:10.3748/wjg.v17.i47.5214. PMID: 22215947; PMCID: PMC3243889.
4. Jayne DG, Guillou PJ, Thorpe H, Quirke P, Copeland J, Smith AMH, et al. Randomized trial of laparoscopic-assisted resection of colorectal carcinoma: 3-year results of the UK MRC CLASICC trial group. J Clin Oncol. 2007 Jul;25(21):3061-8. doi:10.1200/JCO.2006.09.7758. PMID: 17634484.
5. COLOR Study Group. COLOR: A randomized clinical trial comparing laparoscopic and open resection for colon cancer. Dig Surg. 2000;17(6):617-22. doi: 10.1159/000051971. PMID: 11155008.
6. Jeong SY, Park JW, Nam BH, Kim S, Kang SB, Lim SB, et al. Open versus laparoscopic surgery for mid-rectal or low-rectal cancer after neoadjuvant chemoradiotherapy (COREAN trial): survival outcomes of an open-label, non-inferiority, randomised controlled trial. Lancet Oncol. 2014 Jun;15(7):767-74. doi:10.1016/S1470-2045(14)70205-0. PMID: 24837215.
7. Clinical Outcomes of Surgical Therapy Study Group; Nelson H, Sargent DJ, Wieand HS, Fleshman J, Anvari M, Stryker SJ, et al. A comparison of laparoscopically assisted and open colectomy for colon cancer. N Engl J Med. 2004 May;350(20):2050-9. doi:10.1056/NEJMoa032651. PMID: 15141043.
8. Sheng S, Zhao T, Wang X. Comparison of robot-assisted surgery, laparoscopic-assisted surgery, and open surgery for the treatment of colorectal cancer: a network meta-analysis. Medicine (Baltimore). 2018 Aug;97(34):e11817. doi:10.1097/MD.0000000000011817. PMID: 30142771; PMCID: PMC6112974.
9. Soliman MK, Shanker B-A. Robotic Total Mesorectal Excision for Rectal Cancer. In: Tsuda S, Kudsi OY, eds. Robotic-Assisted Minimally Invasive Surgery. Switzerland:Springer; 2019. pp.127-139. doi:10.1007/978-3-319-96866-7_15.
10. Spinelli A, David G, Gidaro S, Carvello M, Sacchi M, Montorsi M, et al. First experience in colorectal surgery with a new robotic platform with haptic feedback. Colorectal Dis. 2017 Sep 14. doi: 10.1111/codi.13882. PMID: 28905524..
11. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg. 2004 Aug;240(2):205-13. doi:10.1097/01.sla.0000133083.54934.ae. PMID: 15273542; PMCID: PMC1360123.
12. Davies B. A review of robotics in surgery. Proc Inst Mech Eng H. 2000;214(1):129-40. doi:10.1243/0954411001535309. PMID: 10718057.
13. Cheng CL, Rezac C. The role of robotics in colorectal surgery. BMJ. 2018 Feb;360:j5304. doi:10.1136/bmj.j5304. PMID: 29440057.
14. Kaw LL, Punzalan CK, Crisostomo AC, Bowyer MW, Wherry DC. Surgical pathology of colorectal cancer in Filipinos: implications for clinical practice. J Am Coll Surg. 2002 Aug;195(2):188-95. doi: 10.1016/S1072-7515(02)01186-9. PMID: 12168965.
15. Redaniel MT, Laudico A, Mirasol-Lumague MR, Gondos A, Uy G, Brenner H. Inter-country and ethnic variation in colorectal cancer survival: comparisons between a Philippine population, Filipino-Americans and Caucasians. BMC Cancer. 2010 Mar;10:100. doi:10.1186/1471-2407-10-100. PMID: 20233442; PMCID: PMC2853518.

16. Jayne D, Pigazzi A, Marshall H, Croft J, Corrigan N, Copeland J, et al. Effect of robotic-assisted vs conventional laparoscopic surgery on risk of conversion to open laparotomy among patients undergoing resection for rectal cancer: the ROLARR randomized clinical trial. JAMA. 2017 Oct;318(16):1569-80. doi:10.1001/jama.2017.7219. PMID: 29067426; PMCID: PMC5818805.
17. Viray, BAG Lopez MPJ, Onglao MA, Tampo MMT, Monroy HJ. Initial experience with robot-assisted oncologic rectal surgery at the Philippine General Hospital. March 2020. Unpublished.
18. Liao G, Li YB, Zhao Z, Li X, Deng H, Li G. Robotic-assisted surgery versus open surgery in the treatment of rectal cancer: the current evidence. Sci Rep. 2016 May;6:26981. doi:10.1038/srep26981. PMID: 27228906; PMCID: PMC4882598.
19. Cho MS, Baek SJ, Hur H, Min BS, Baik SH, Lee KY, et al. Short and long-term outcomes of robotic versus laparoscopic total mesorectal excision for rectal cancer: a case-matched retrospective study. Medicine (Baltimore). 2015 Mar;94(11):e522. doi:10.1097/MD.0000000000000522. PMID: 25789947; PMCID: PMC4602485.
20. Kang SB, Park JW, Jeong SY, Nam BH, Choi HS, Kim DW, et al. Open versus laparoscopic surgery for mid or low rectal cancer after neoadjuvant chemoradiotherapy (COREAN trial): short-term outcomes of an open-label randomised controlled trial. Lancet Oncol. 2010 Jul;11(7):637-45. doi:10.1016/S1470-2045(10)70131-5. PMID: 20610322.
21. Zhang X, Wei ZQ, Bie MJ, Peng XD, Chen C. Robot-assisted versus laparoscopic-assisted surgery for colorectal cancer: a meta-analysis. Surg Endosc. 2016 Dec;30(12):5601-14. doi:10.1007/s00464-016-4892-z. PMID: 27402096.
22. Somashekhar SP, Ashwin KR, Rajashekhar J, Zaveri S. Prospective randomized study comparing robotic-assisted surgery with traditional laparotomy for rectal cancer—Indian study. Indian J Surg. 2015 Dec;77(Suppl 3):788-94. doi:10.1007/s12262-013-1003-4. PMID: 27011458; PMCID: PMC4775566.
23. Bokhari MB, Patel CB, Ramos-Valadez DI, Ragupathi M, Haas EM. Learning curve for robotic-assisted laparoscopic colorectal surgery. Surg Endosc. 2011 Mar;25(3):855-60. doi:10.1007/s00464-010-1281-x. PMID: 20734081; PMCID: PMC3044842.
24. Valverde A, Goasguen N, Oberlin O, Svrcek M, Fléjou JF, Sezeur A, et al. Robotic versus laparoscopic rectal resection for sphincter-saving surgery: pathological and short-term outcomes in a single-center analysis of 130 consecutive patients. Surg Endosc. 2017 Oct;31(10):4085-91. doi:10.1007/s00464-017-5455-7. PMID: 28271268.
25. de Jesus JP, Valadão M, de Castro Araujo RO, Cesar D, Linhares E, Iglesias AC. The circumferential resection margins status: A comparison of robotic, laparoscopic and open total mesorectal excision for mid and low rectal cancer. Eur J Surg Oncol. 2016 Jun;42(6):808-12. doi:10.1016/j.ejso.2016.03.002. PMID: 27038996.
26. Baik SH, Kwon HY, Kim JS, Hur H, Sohn SK, Cho CH, et al. Robotic versus laparoscopic low anterior resection of rectal cancer: short-term outcome of a prospective comparative study. Ann Surg Oncol. 2009 Jun;16(6):1480-7. doi:10.1245/s10434-009-0435-3. PMID: 19290486.