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Original Research Article

A retrospective audit of robotic versus laparoscopic anterior resection for diverticular disease in a single surgeon's experience

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ABSTRACT

Background: There has been a shift towards elective resection for recurrent or complicated diverticular disease to prevent recurrent episodes of diverticulitis. Our study aims to compare the outcomes in elective robotic and laparoscopic anterior resection for diverticular disease by a single surgeon experienced in both techniques.
Methods: This is a retrospective study of patients who underwent elective anterior resections at Nepean Public Hospital, Nepean Private Hospital, and Sydney Adventist Hospital (SAN) in the last 10 years. The single surgeon is an experienced surgeon who has performed laparoscopic anterior resections from January 2013 to December 2018; and mainly robotic anterior resections from January 2018 to July 2022. The primary outcome of this study was to determine if there were any differences in length of stay and post-operative complications in laparoscopic and robotic anterior resections. Secondary outcome measures included operating time, rate of conversion to open surgery, and 30-day mortality and morbidity.
Results: There were 53 patients included in this study. There was no significant difference in conversion to open rates (p=0.528), mean operative time (p=0.095), stoma formation rates (p=0.528) and post-operative complication rates (0.609). Length of stay was significantly shorter in the robotic group (p=0.024), and a higher proportion of patients who had laparoscopic surgery stayed for ≥6 days (p=0.08). There were no anastomotic leakages, or 30-day mortality and morbidity.
Conclusions: Robotic anterior resection is a feasible approach in experienced hands and produces comparable results to laparoscopic anterior resection for diverticular disease in terms of length of stay, post-operative complications, and operative timings.

Keywords: Anterior resection, Diverticulitis, Diverticular disease, Laparoscopic, Minimally invasive surgery, Robotic

INTRODUCTION

Diverticular disease is an increasingly common condition especially in the Western world.[1] In Australia, over one third of people over 60 years old have diverticular disease. Episodes of complicated diverticulitis can lead to complications such as perforation, peritonitis, strictures, fistulas, sepsis and death causing significant morbidity and mortality in patients.[1,2] Hence, there has been a shift towards elective resection for recurrent or complicated diverticular disease.[1,3] This can be carried out through open or minimally invasive techniques (MIS), namely laparoscopic or robotic surgery. Current literature supports MIS over open surgery due to improved morbidity, shorter length of stay, and early return to activities of daily living.[4,3] Laparoscopic surgery has limitations such as two-dimensional imaging, limited mobility, less ergonomic freedom and an unstable camera

platform.[5] Robotic surgery has been developed to offer advantages over laparoscopic techniques, particularly in anatomically limited spaces such as a narrow pelvis.[6-8] It provides better three-dimensional depth of field, seven degrees of wrist-like motion allowing increased and more natural range of motion, tremor-filtering articulating instruments, a stable camera platform, results in better ergonomics and less surgeon fatigue.[7] Furthermore, the robotic approach is useful in allowing more precise optical definition and dissection in arduous pelvic dissection, especially in complicated diverticulitis.[9]

In colorectal cancer surgery, laparoscopic techniques have proven to be non-inferior to open techniques oncologically. With the recent uptake of robotic surgery, studies have supported its safety and efficacy compared to laparoscopic surgery.[7] However, published comparisons of minimally invasive approaches in diverticular disease are limited. As such, our study aims to compare the outcomes of elective robotic and laparoscopic anterior resection for diverticular disease by a single experienced colorectal surgeon well-versed in both techniques.

METHODS

This is a retrospective study of patients who underwent elective anterior resections at Nepean Public Hospital, Nepean Private Hospital, and Sydney Adventist Hospital (SAN) in the last 10 years. The single surgeon is an experienced surgeon who has performed laparoscopic anterior resections from January 2013 to December 2018; and mainly elective robotic anterior resections from January 2018 to July 2022. Prior to January 2018, the surgeon had already begun learning, and become proficient in the robotic platform. Patient demographics, operative details, and complications have been retrospectively retrieved through hospital medical records. Ethics approval was obtained.

All patients who had diverticular disease and underwent an elective anterior resection by this surgeon (WB) were included. All patients with who underwent emergency surgery or had surgery for a colonic malignancy were excluded. The primary outcome of this study was to determine if there were any differences in length of stay and post-operative complications between laparoscopic and robotic anterior resections. Secondary outcome measures included operating time, rate of conversion to open surgery, and 30-day mortality and morbidity.

Statistical analysis

Analysis of the data was performed using statistical software SPSS version 26.0 (SPSS, Inc, Chicago, IL). All continuous variables were collected as mean and standard deviation. Continuous data with normal distribution was presented as a mean with 95% confidence interval, and unpaired t-test was used to test differences between groups. Categorical variables were collected as frequencies and percentages and were compared by Chi-squared test or Fisher's exact test. A *p*-value of <0.05 was considered statistically significant.

RESULTS

A total of 53 patients were included in this study. The mean age of patient cohort was 59 years (36-80 years) and 24/53 (45.3%) were males. The mean BMI for the entire cohort was 28.9 (20.3-41.8). Patient demographics are as listed in Table 1 and 2.

Table 1: Patient demographics.

Category	
Total number of patients	53
Age at surgery (Mean, range)	59 (36-80)
BMI (Mean)	28.9 (20.3-41.8)
Patient sex	
Male (n, %)	24 (45.3)
Female (n, %)	29 (54.7)

Table 2: Patient demographics-laparoscopic versus robotic surgery.

Patient characteristics	Laparoscopic (n=28) (%)	Robotic (n=25) (%)
Age at surgery (Mean, range)	57 (36-80)	61 (40-80)
BMI (Mean)	29.3 (22-38.5)	28.0 (20.3-41.8)
Patient sex		
Male (n, %)	13/28 (46.4)	11/25 (44)
Female (n, %)	15/28 (53.6)	14/25 (56)
Indications for surgery		
Recurrent diverticulitis	13/28 (46.4)	15/25 (60)
Recurrent diverticulitis with abscess	6/28 (21.4)	0/25 (0)
Failure to resolve	2/28 (7.1)	1/25 (4)
Failure to resolve with abscess	2/28 (7.1)	0/25 (0)
Diverticular stricture	2/28 (7.1)	5/25 (20)
Colovesical fistula	2/28 (7.1)	3/25 (12)
Colovaginal fistula	1/28 (3.6)	1/25 (4)

Of the 53 patients, 28 patients underwent laparoscopic anterior resection, and 25 underwent robotic anterior resection. The mean age in the laparoscopic group was slightly lower at 57 years, compared to 61 years in the robotic group. The mean BMI in the laparoscopic and robotic group was 29.3 and 28.0 respectively. There were 13 (46.4%) males in the laparoscopic group and 11 (44%)

males in robotic group. The most common indication for surgery was recurrent diverticulitis (46.4% laparoscopic approach, 60% robotic approach). Other indications included diverticular abscess, smouldering diverticulitis, diverticular strictures, and diverticular fistulas (Table 2).

There were 49 patients who underwent high anterior resections, and 4 who underwent low anterior resections. Among the laparoscopic high anterior resections, one patient (3.6%) required conversion to an open anterior resection due to dense adhesions to pelvic side wall. Only one patient (3.6%) required stoma formation after a laparoscopic low anterior resection. The mean operative time for laparoscopic anterior resection was 239 minutes, and that for robotic was 270 minutes (p=0.095). Mean robotic console time was 126 minutes. When comparing the initial 10 cases in both the robotic and laparoscopic group, the mean operative time was 225 minutes and 237 minutes respectively (p=0.69). Comparing the last 10 cases in each group in this series, the mean operative time was 287 minutes for the robotic group and 249 minutes for the laparoscopic group (p=0.29). A summary of operative details are listed in Table 3.

Table 3: Operative details.

	Laparoscopic (n=28)	Robotic (n=25)	P value
Type of anterior resection (%)			-
High (%)	25/28 (89.3)	24/25 (96)	-
Low (%)	3/28 (10.7)	1/25 (4)	-
Conversion to open rate (%)	1/28 (3.6)	0/25 (0)	0.528
Mean operative time (minutes, range)	239±52 (160-381)	270±61 (181-455)	0.095
Mean console time (minutes, range)	-	126±52 (60-304)	-
Stoma formation (%)	1/28 (3.6)	0/25 (0)	0.528
Post-operative complications (%)	3/28 (10.7)	3/25 (12)	0.609
Drain site infection	1	1	
Drain site bleed	1	0	
Wound infection	1	1	
Urinary tract infection	0	1	
30-day morbidity (%)	0	0	-
30-day mortality (%)	0	0	-
Mean LOS (days, range)	6.8 (4-15)	5.2 (3-8)	0.024
LOS ≥6 days (%)	10/28 (58.8)	8/25 (32)	0.08

There were a total of six patients with post-operative complications; three patients (10.7%) in the laparoscopic group and three patients (12%) in the robotic group (p=0.609). These complications included: drain site infection (2), drain site bleeding (1), wound infection (2), and urinary tract infection (UTI) (1). There were no anastomotic leakages recorded. There was no 30-day morbidity or mortality in our study cohort. There was a significantly longer length of stay (LOS) in the laparoscopic group (6.8 days) compared to the robotic group (5.2 days) (p=0.024), with 58.8% of patients in the laparoscopic group having a LOS of 6 days or longer, compared to 32% of the patients in the robotic group (p=0.08)

DISCUSSION

The use of robotics in colorectal surgery has been steadily increasing. However, longer operating times in robotic surgery due to set up, docking, and increased costs has limited its widespread adoption.[7] Moreover, additional training is required for staff to operate the machinery, and there is a learning curve for surgeons learning this new platform. However, recent studies have demonstrated significant reductions in length of stay, conversion to open surgery rate, and hospital costs for surgeons performing a high volume of robotic surgery.[5] A recent systematic review of robotic resections in diverticular disease demonstrated that robotic surgery for diverticular disease was associated with a reduced conversion to open surgery, but a longer operating time as compared to laparoscopic surgery.[10] In another study comparing outcomes of robotic versus laparoscopic colorectal procedures for both benign and malignant conditions, performed by surgeons experienced in both robotic and laparoscopic procedures, they found no statistical difference in length of stay, time to return of bowel function, and time to discontinuation of patient-controlled analgesia.[11]

Robotic rectal surgery has advantages over laparoscopic surgery in terms of reducing length of hospital stay (LOS), translating to potential cost-savings, and reduced risks of hospital-associated complications for patients.[5] Studies have demonstrated a less complicated post-

operative course with robotic surgeries, and a more rapid bowel recovery, which led to significantly shorter length of stay, and a quicker return to function post-operatively.[12] Our results also resonated this finding, showing significantly shorter LOS after robotic surgery (p= 0.024) in the diverticular disease cohort. Crippa et al, also reported a significantly shorter LOS in the robotic group when compared with the laparoscopic group in rectal cancer surgery; 21.45% in the robotic group had a LOS ≥6 days compared to 43.11% in the laparoscopic group (p<0.001).[13] Patients undergoing robotic surgery were also 38% less likely to remain in hospital for 6 days or more compared to laparoscopic surgery. Interestingly, robotic surgery was the only independent protective factor from a prolonged LOS.[13] These encouraging findings have highlighted that robotic surgery not only improves patient outcomes with quicker recovery and shorter length of hospital stay, but also can have a positive impact on the health care system.

Our study had only 6 patients who had post-operative complications and there was no significant difference (p=0.609) in the complication rates between the two groups. None of the patients in our cohort had anastomotic leaks. This is consistent with the findings in a study by Gass et al comparing robotic and laparoscopic left-sided colectomies, where there was no statistical difference in anastomotic leak rates or intraoperative complications between both groups.[14]

The 30-day mortality rates are reportedly low in both elective laparoscopic and robotic surgery for rectal cancer. Crippa et al showed both techniques had similar rates of 30-day mortality.[13] Similarly, Myrseth et al also demonstrated that 30-day mortality did not differ between robotic-assisted resection and laparoscopic resection, which is consistent with other larger studies.[15] This was similar in our study where there was no 30-day morbidity or mortality.

Longer operating times is one of the reasons for hesitancy in the uptake of robotic surgery. These are generally associated with a greater risk of complications including complications from prolonged general anaesthesia, bleeding and venous thromboembolism; shorter operating times have been a goal in improving surgical outcomes.[16] In the study by Gass et al, operating time was significantly longer in robotic group compared to laparoscopic group for patients with diverticular disease for left-sided colectomies.[14] A confounding factor in that study for the longer operative time was proposed to be the use of the da Vinci Si® platform at the initial stages [n = 29 (16.2%) da Vinci Si® vs. n = 150 (83.8%) da Vinci Xi®].[14] The newer da Vinci Xi® was subsequently easier to dock and set up. In the systematic review by Larkins et al., operating time was longer with a robotic approach (p=0.03) compared to laparoscopic approach.[10] Our study however demonstrated no significant difference in operating time between the laparoscopic and robotic anterior resection group (p=0.095); there was no significant differences in operating times in the initial or last 10 cases of the series. Moreover, our study had included the robotic docking time as part of the total robotic operating time, and as such, we can deduce that the actual operating time was in fact shorter in the robotic group than in the laparoscopic approach. These findings could be attributed to better visualisation and articulating instruments with the robotic platform, especially when approaching a phlegmonous diverticular segment, as well as the experience of the colorectal surgeon who was already well versed in both laparoscopic and robotic surgery. These suggest that once past the learning curve for robotic surgery, the utilisation of robotic surgery not only improves visualisation and surgeon physical health intra-operatively, but it also improves patient outcomes such as length of stay and operating time.

Parascandola et al described a single surgeon's experience in performing robotic-assisted low anterior resections: the mean operating time was 286 min, with a significant reduction in mean operating time from the first to the fourth quartile of cases, suggesting that the learning curve was reached after 55–65 cases.[17] Similar to the study by Gass et al, our initial operating platform was also da Vinci Si®, which then progressed to the da Vinci Xi®.[14] A study by Melich et al also showed that the learning curve in robotic surgery was faster than that of laparoscopic surgery.[18] However, in our cohort, our operating surgeon was already an experienced surgeon when he undertook these operations, hence there was no real significant reduction in mean operating time throughout our cases, once again suggesting that in experienced hands, setting up and docking of robot becomes much less arduous and requires minimal additional time. Proposed methods to improve operative time in robotic surgery include standardisation of docking steps and repetitive training with identical teams to reduce operative time.[14] One study found that operating times were almost identical in right-sided colectomy group where undocking the robot is not a requirement.[11] However, during left-sided robotic colon resections where robot repositioning was a mandatory step, there was a significant difference of approximately 30 minutes in favour of the laparoscopic group.[11] However, with the development of the integrated table motion for the da Vinci Xi® and variations in port placements, more flexibility and less re-docking may be required, which significantly reduces operating time.[19]

Surgical experience plays a large role in the likelihood of conversion to open surgery. In the study by Kowalewski et al. where surgeons had performed at least 100 robotic procedures, the odds of conversion were significantly lower with the robotic approach, independent from the number of laparoscopic procedures performed.[20] Conversion to open surgery is usually associated with more complications, longer hospital stays and poorer long-term outcomes.[7,15] Many studies have shown that robotic surgery is associated with significantly lower conversion rates as opposed to laparoscopic surgery in

rectal cancers.[5,13,15,21] Our study also reflects this with a 0% conversion to open in the robotic group. This could be because robotic surgery allows improved access to difficult to reach regions such as the narrow pelvis. Laparoscopic surgery on the other hand does not have this advantage and access to areas such as a narrower pelvis in the obese are more difficult.[5,22] In the ROLARR trial comparing robotic and laparoscopic rectal cancer surgery, the conversion rate to open surgery was not statistically significant. However, subgroup analysis showed that the conversion rate in the laparoscopic group was significantly higher in male (narrow pelvis) and obese subpopulations than in the robotic group.[8]

As with all surgeries using a new platform, there will be a learning curve with longer operating times in the beginning. However, with consistent volume and practice, we believe that the time taken for robotic surgery in experienced hands will be similar to that of laparoscopic surgery, if not shorter, due to the precision and vision that the robotic platform provides in a difficult diverticular phlegmon or fistula resections with benefits to both the surgeon and patient.

Our study findings should be interpreted in the context of the following limitations. Due to the retrospective nature of the analysis, there is potential of confounding by unmeasured factors. The number of the study is low, and results of this study represent a single surgeon and therefore may not be generalizable to other surgeons who have varying experience in either laparoscopic or robotic surgery. We acknowledge that there is a learning curve involved for each surgeon to become an experienced operator in each approach. Further research exploring the learning curve of surgeons and larger patient cohort is needed to confidently state the non-inferiority of each approach.

CONCLUSION

There are limited studies comparing outcomes of robotic versus laparoscopic anterior resection for diverticular disease. Our study is one of the first studies comparing an experienced colorectal surgeon's outcomes in minimally invasive anterior resections and demonstrated that robotic anterior resection is a feasible approach in experienced hands and produces comparable results to laparoscopic anterior resection for diverticular disease in terms of length of stay, post-operative complications, and operative timings.

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