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Laparoscopic, Endoscopic and Robotic Surgery 5 (2022) 57–60

Contents lists available at ScienceDirect

Laparoscopic, Endoscopic and Robotic Surgery

journal homepage: www.keaipublishing.com/en/journals/laparoscopic-endoscopic-and-robotic-surgery

Emergency robotic colorectal surgery during the COVID-19 pandemic: A retrospective case series study

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ARTICLE INFO

Article history:
Received 31 January 2022
Received in revised form
9 March 2022
Accepted 14 March 2022
Available online 22 March 2022

Edited by Qingjie Zeng

Keywords:
Emergency surgery
Robotic colorectal surgery
Minimally invasive surgery
COVID-19

ABSTRACT

Objective: While interest in elective robotic surgery is growing, use in emergency setting remains limited due to challenges posed by sicker patients, advanced pathology and logistical issues. During the COVID-19 pandemic, robotic surgery could provide the benefit of having the surgeon away from the bedside and reducing the number of directly exposed medical staff. The objective of this study was to report patient outcomes and initial learning experience of emergency robotic colorectal surgery during the COVID-19 pandemic.

Methods: A case series study was conducted, including patients undergoing emergency robotic colorectal surgery between February 2020 and February 2021 at Queen Alexandra Hospital in Portsmouth, UK. Patient data were collected from an ethics approved prospective database. Patient demographics, operative time, conversions and postoperative complications were recorded. In addition, readmissions, length of stay and short-term oncological outcomes were analyzed.

Results: Ten patients with median age 64 y (range, 36–83 y) were included. Four patients had robotic complete mesocolic resection for obstructing cancers. Six had colorectal resections for benign disease in emergency setting. All were R0 with a mean lymph node harvest of 54 ± 13. Mean operative time was 249 ± 117 min, the median length of stay was 9.4 d (range, 5–22 d). Only one patient was given a temporary diverting ileostomy. There were no grade III/V complications and no 30-day mortality.

Conclusions: Provided an experienced team and peri-operative planning, emergency robotic colorectal surgery can achieve favorable outcomes with benefits of radical lymph node dissection in oncological cases and avoidance of diverting stoma.

1. Introduction

The robotic platform addresses many of the technical and ergonomic limitations of laparoscopic surgery,[1] and results in reduced conversions, faster recovery and shortened hospital stay.[2] Difficult operative access and the technically demanding procedures with the need for enhanced dexterity, precision and stability are the key areas where the robotic approach is particularly beneficial. Rectal cancer surgery, complete mesocolic excision (CME) surgery for colon cancer and complex diverticular resections remain the popular indications for robotic surgery in the elective colorectal setting.

Over 25% of patients with colorectal cancer present as an emergency,[3] and are associated with higher rates of morbidity, mortality and stoma formation compared to elective surgery.[4] Emergency cases are challenging due to inflamed fragile tissues and less obvious anatomical planes. Furthermore, distended small bowel, risk of contamination and hemodynamic instability can add

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https://doi.org/10.1016/j.lers.2022.03.001

further complexity for the surgeon in such situations. Robotic surgery can provide the enhanced 3D view, fully wristed dexterity instruments and four operating arms for the surgeon, and stability of the platform that can address some of these issues. However, the logistical challenges of out of hours operating, stability of the patient, and availability of trained theatre staff remains a significant barrier to the wider adoption of robotic assisted surgery techniques in the emergency setting.

During the COVID-19 pandemic, the emphasis on reducing the number of theater personal and scrubbed members of surgical team has been clear. The need for full personal protective equipment in performing emergency surgery and the use of CO_2 insufflation has caused concerns for many. Although the presence or absence of COVID-19 viral particles has not been clearly established and guidelines are based on weak evidence, measures to mitigate CO_2 release into the operating room should be performed.[5] And there is an added benefit in robotic surgery of having the surgeon away from the bedside and reducing the number of directly exposed medical staff.[6]

Queen Alexandra Hospital in Portsmouth is a recognized training center for robotic colorectal surgery at UK and has been performing regular elective robotic colorectal resections since 2012 with an experience of over 600 major resections. With increasing experience and staff training, patients having emergency colorectal surgery were selectively offered robotic emergency surgery when a robotic colorectal surgeon was on call and experience theatre team was available. The aim of this study was to report patient outcomes and initial learning experience of emergency robotic colorectal surgery during the COVID-19 pandemic.

2. Materials and methods

2.1. Patient's selection

Patients were enrolled, who had emergency robotic colorectal surgery from February 2020 to February 2021 at Queen Alexandra Hospital in Portsmouth, UK. All patients were admitted to the surgical admissions unit with acute abdomen and investigated with a diagnostic CT scan of the abdomen and pelvis.

2.2. Data collection

Data pertaining to patient demographics, such as age, body mass index (BMI) and the American Society of Anesthesiologists (ASA) classification were collected. Operative time and conversions were captured, and 30-day postoperative complications, readmissions, length of stay and short-term oncological outcomes were evaluated.

2.3. Surgical procedure

All procedures were carried out using the da Vinci X ® (Intuitive Surgical, USA) fourth generation system. In case of right sided cancers, a CME and central vascular ligation was performed, as this is the standard of care in our unit. In all cases involving colorectal resection, an intracorporeal isoperistaltic stapled anastomosis was made and the specimen was extracted with a Pfannenstiel incision. Vascularization was evaluated in all robotic procedures using indocyanine green. For left sided resections, the standardized single docking technique for anterior resection was used.

To achieve an adequate operative view of the dissection plane, two robotic instruments should be lifting the mesocolon and the assistant applying traction to the floor during the dissection (Fig. 1A). If needed, a Hem-o-Lok® clip can be used to fix a loop of bowel to the side wall (Fig. 1B) to help lift the bowel. A stapled colorectal anastomosis was fashioned and reinforced with Vicryl 3/0 sutures in an attempt to avoid a diverting stoma. No bowel preparation was used in these cases. A single dose of prophylactic antibiotics was given at induction and further doses prescribed based on the clinical course.

2.4. Statistical analysis

Statistical analysis was carried out using the software package IBM SPSS v26. Normally distributed data was presented as mean ± SD. Nonnormally distributed data was in median with range.

3. Results

3.1. Patient demographics

Patient demographics are listed in Table 1. Totally, 10 patients were enrolled, including 7 males and 3 females, with a median age of 64 y (range, 36–83 y). The median BMI was 27 kg/m^2 (range, 19–41 kg/m^2). Four patients had emergency robotic resection (CME right colectomy) for an obstructing colon cancer. Six patients had emergency robotic surgery for benign disease, including 3 complicated diverticulitis with perforation and abscess, 2 inflammatory bowel diseases with fistulation and 1 parastomal hernia with strangulated small bowel.

3.2. Clinical and oncological outcomes

Clinical and oncological outcomes are presented in Table 2. The mean operative time was 249 ± 117 min. All cancer resections were R0 with mean lymph node harvest of 54 ± 13. Median length of stay

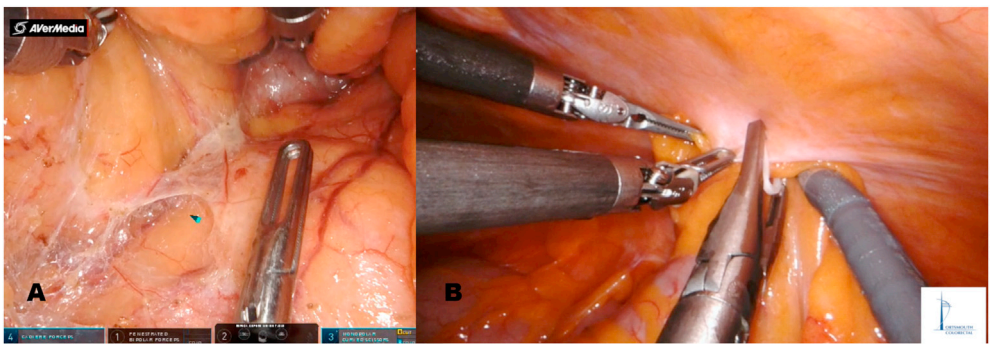

Fig. 1 Tips for adequate operative view during left sided colon resection
Illustration of the operative view from medial to lateral towards the splenic flexure with 2 robotic instruments lifting the mesocolon and the assistant applying traction to the floor (A). Use of a Hem-o-Lok® clip to fix a loop of bowel to the side wall (B).

Table 1
Patient demographics and peri-operative findings

No.	Age, y	Gender	BMI, kg/m^2	ASA grade	Diagnosis	Surgery
1	83	Female	22	II	Diverticulitis + colovesical fistula	AR
2	76	Female	19	III	Complicated Crohn's disease with obstruction	Right hemicolectomy and repair of bladder fistula
3	36	Female	41	II	Ulcerative colitis with fulminant colitis	Subtotal colectomy + definitive ileostomy
4	74	Male	24	II	Perforated diverticular disease (Hinchey3)	AR
5	59	Male	24	II	Perforated diverticular disease (Hinchey3)	AR
6	51	Male	22	II	Obstructed parastomal hernia with strangulated small bowel	Bowel resection + parastomal hernia repair
7	74	Male	27	II	Perforated right colon cancer	CME (right hemicolectomy)
8	75	Male	26	III	Intussusception right colon cancer	CME (right hemicolectomy)
9	71	Male	33	III	Obstruction and perforated transverse colon cancer	CME (extended right hemicolectomy)
10	37	Male	25	I	Locally advanced right colon cancer	CME

AR, anterior resection; ASA, the American Society of Anesthesiologists; CME, complete mesocolic excision.

Table 2
Clinical and oncological outcomes

	$n = 10$
Operative time, mean ± SD, min	249 ± 117
Length of stay, median (range), d	9.4 (5–22)
Lymph node harvest, mean ± SD	54 ± 13
Clavien-Dindo grade, *n* (%)	
None	6 (60.0)
I	2 (20.0)
II	2 (20.0)
III	0 (0.0)

was 9.4 d (range, 5–22 d). The cancers were located in ascending colon in 2 patients, cecum in 1 and transverse colon in 1. They were T4 tumors presenting with colonic obstruction.

There were no conversions to laparoscopic surgery or laparotomy. There were no Clavien-Dindo grade III/IV complications and no 30-day mortality. There were 4 cases with complications, which occurred within the first 10 days after surgery. Two patients had an acute kidney injury managed with fluid resuscitation, 1 had an ileus, and 1 had an intra-abdominal abscess treated with antibiotics. There were no cases of surgical site infections.

3.3. Complicated diverticulitis

All left sided resections had primary anastomosis, except one patient who was given a temporary colostomy for diverticulitis with colovesical and colovaginal fistulae, due to frailty and medical comorbidities. Fig. 2 shows the abdominal CT scan image of the 59-year-old patient with diverticulitis and a 45.4 mm abscess, who was able to be treated without the need for a temporary stoma and did not have any major postoperative complications.

Fig. 2 Imaging of complicated diverticulitis
Transverse section CT scan image showing complicated diverticulitis with a 45.4 mm abscess.

4. Discussion

The robotic approach has been used for a variety of clinical indications with good postoperative outcomes. Literature review reports some case series of emergency robotic operations, such as upper gastrointestinal,[7–9] and colorectal procedures.[10–12] These studies underlined the feasibility of robotic approach in emergency abdominal surgery, with the benefits of fewer complications, quicker postoperative recovery and shorter length of stay in emergency setting. This is the first case series study with the novel use of a robotic platform in emergency colorectal surgery.

In this study, the mean operative time was 249 ± 117 min, which is acceptable for major colorectal resections. A recent study by Anderson et al, comparing urgent robotic subtotal colectomy with laparoscopic procedures, found that robotic procedures took 29 min longer than laparoscopic with an average of 323 min. However, the difference was not significant.[12] The median length of stay was 9.4 d (range, 5–22 d), which favorably compares with literature stating a mean length of stay of 10 d (range, 3–23 d) after laparoscopic emergency colonic resection.[13]

It has been shown that in emergency surgery, the principles of oncologic resection can be respected when considering and analyzing the extent of the resection, the surgical margins and the number of harvested lymph nodes.[14] However, especially in locally advanced tumors that warrant multivisceral *en bloc* resection and radical lymph node dissection, which has prognostic and therapeutic implications, the robotic platform can offer previously mentioned technical advantages to facilitate oncological resection and to provide a high lymph node harvest, as seen in our series. In colorectal cancer surgery, over 25% of the patients present in emergency setting. This number is likely to increase due to the stage migration effect of the COVID-19 pandemic. This delayed presentation may increase the rates of long-term complications and overall mortality.[15] Currently, during the COVID-19 pandemic, we have observed patients presenting in the emergency setting in a more advanced stage of disease. All the cancers operated in this series were T4 tumors.

Patients admitted for colorectal surgery in the emergency setting present several challenges, including fluid shifts, hemodynamic instability, obstruction and poor nutritional state. All of these are known risk factors for postoperative complications.[16] Literature analyzing outcomes after open emergency colorectal surgery reports that the overall in-hospital mortality rate can be as high as 14.4%, secondary to peritonitis, bowel ischemia, intraoperative bleeding and multiorgan failure.[17] In our study there were no Clavien-Dindo grade III/V complications and no 30-day mortality. There were no cases of surgical site infections, which is a cause of major morbidity after open emergency surgery. The reduction of

surgical site infections may be partly responsible for reduced morbidity in our study.

Anastomotic complications are major contributors to morbidity and mortality in bowel surgery and are prevented by proper vascularization and tissue integrity.[18] To assess quality of the anastomosis, indocyanine green can be used to evaluate perfusion of the anastomosis.[19] In addition, suture reinforcement can be performed, even in a low pelvic anastomosis, resulting in avoiding a temporary stoma in most patients. A study concerning emergency surgery of the colon reported the most common operations were Hartmann's procedures (23.8%) and 59.4% of patients needed to have a temporary stoma.[17] In our case series, only one patient was given a temporary stoma for diverticulitis with colovesical fistula, due to frailty and medical comorbidities.

Additionally, obstructed bowel with reduced intra-abdominal space can pose technical challenges for minimal access surgery. Inflammatory conditions are associated with fragile tissue with risk of bleeding and distortion of the anatomical planes. This can lead to a higher conversion rate from minimally invasive surgery to open surgery in the emergency setting.[20] These conditions and advanced stage T4 cancers with bowel obstruction and/or perforation can be relative contra-indications for laparoscopic surgery. One might argue it is not suitable to perform emergency robotic colorectal surgery taking in account that emergency laparoscopic procedures often have to be converted to open surgery. However, the robotic platform has some technical advantages in comparison to laparoscopic technique as previously described. Robotic surgery is associated with a lower conversion rate compared to laparoscopic technique in the elective setting.[21,22] In our study, there was no need for conversion, possibly aided by the technical advantages of the robotic platform.

What needed to change moving from scheduled surgery to emergency setting, especially in the COVID-19 era with staff shortage, was the general mindset to get the surgery performed as fast as possible. Although robotic emergency surgery takes 30 minutes longer than laparoscopic emergency surgery,[12] it can be reduced by team training and experience. Additionally, it must be taken into account that there is a higher conversion rate in laparoscopic surgery and length of stay after open and laparoscopic surgery is significantly longer, keeping patients in-hospital with associated risk of COVID-19 contact and adding to the burden of bed capacity. The reduced length of stay and surgeon's distance from the bedside during surgery results in a risk reduction for the patient as well as the surgeon. Careful planning, team training and a change in mindset are essential prerequisites to achieve a successful emergency robotic program.

The limitations of this study are small numbers, clinical diversity of cases, the retrospective nature of the case series and possible selection bias. An experienced team was not always available, therefore limiting the cases that were robotically performed in emergency setting.

5. Conclusions

Emergency robotic colorectal surgery can achieve favorable outcomes with an experienced team and peri-operative planning. Oncological resections can be carried out respecting the principles of oncologic resection with radical lymph node dissection, and technical advantages of the robotic platform are considerable, including suture reinforcement of the anastomosis avoiding a temporary stoma.

Conflict of interest

The authors declare no conflicts of interest.

Ethics approval

This research data was obtained from an ethics approved prospective database by the Portsmouth Hospitals University.

Patient consent for publication

Consent for publication was obtained from all participants included in the study.

Acknowledgments

The authors would like to thank our anesthetic and theatre team for their efforts in dealing with logistic challenges and making these emergency robotic surgery cases possible after hours.

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