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Feasibility of Ambulatory Robotic Colorectal Cancer Surgery: The Initial Experience of a UK Teaching Hospital

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ABSTRACT

Introduction: The development of robotic surgery in conjunction with enhanced recovery after surgery protocols have had a positive impact on shortening inpatient hospital stay. This has led to widespread interest in ambulatory robotic colorectal surgery (ARCS) around the world. In this context, there is a need to assess the feasibility and safety of ARCS.

Methods: Certain patient and procedure-specific eligibility criteria were set for ARCS in our study. The care and management given during the peri-operative period were guided by enhanced recovery guidelines. Post-operative instructions were clearly communicated to patients and provided with an escalation pathway on discharge. Virtual post-operative monitoring and calls were made three days post-operatively.

Results: All three anterior resection of the rectum (AR) procedures for colorectal cancer included in our study were completed robotically, without conversion to open or laparoscopic surgery and discharged within 23 hours of hospital admission and within 17 hours post their respective operations. At 30-day follow up, none of the patients reported any surgical complications.

Conclusions: Our initial experience results demonstrate the potential for ARCS as a feasible and safe option for selected patients undergoing colorectal cancer surgery. Future studies are needed to further elucidate the safety and efficacy of this technique in larger patient populations. To our knowledge, this is the first report of ambulatory robotic colorectal surgery in the United Kingdom.

Keywords: Ambulatory Robotic Colorectal Surgery; Colorectal Cancer; Enhanced Recovery after Surgery; Virtual Ward

Abbreviations: ARCS: Ambulatory Robotic Colorectal Surgery; AR: Anterior Resection; ERAS: Enhanced Recovery After Surgery; MIS: Minimally Invasive Surgery; BMI: Body Mass Index; ASA: American Society of Anaesthesiologists

Introduction

Enhanced recovery after surgery (ERAS) has been a key element of improving care in colorectal surgery since the late 1990s and has contributed significantly to improving patient outcomes and shortening recovery periods [1,2]. This approach focused on reducing the stress response after surgery through more effective pain management, early mobilisation and oral nutrition. It also included pre-operatively optimising patient physiology through aggressive management of co-morbidities and prehabilitiation [3-7]. The evidence-based guidelines from ERAS society have contributed to the shortening of average inpatient stay after colorectal surgery from weeks to a few days, as well as a reduction in post-operative morbidity and mortality [8-10]. In conjunction with ERAS protocol, the development of mini-

mally invasive surgery (MIS) seems to have a synergistic relationship in reducing inpatient length of stay, intensive care admissions, time to normal bowel function and patient satisfaction [8-13]. The development of robotic surgery has shortened this even further when compared to laparoscopic surgery. The development of robotic surgery has been one of the major advances in the field of colorectal surgery, allowing for greater precision and speedier patient recovery when compared to laparoscopic surgery [12,14-17]. Surgeons have continued to refine the robotic technique and enhanced recovery after surgery protocols aiming for further shortening of inpatient hospital stay. The published ambulatory robotic colectomies performed so far demonstrated the feasibility and safety of this procedure [18-22]. This has led to widespread interest in ambulatory robotic colectomies from hospitals around the world. As such, many other hospitals have followed suit by implementing their own ERAS protocols in order to improve ambulatory robotic techniques care. Based in a teaching hospital in the UK we aimed to combine the innovation of robotic surgery and virtual patient care to deliver ambulatory colorectal cancer surgery. We designed very strict inclusion and exclusion criteria as case selection is key to deliver this service. We would like to report our successful initial experience in performing three ARCS for colorectal cancer.

Material and Methods

The three ARCS included in this study were done in our tertiary colorectal referral center between November 2022 and January 2023. They were performed by two colorectal consultants, with the Da Vinci X surgical system (Intuitive Surgical, Sunnyvale, CA, USA). ARCS was defined as hospital stay of less than 23 hours post hospital admission. Informed consent was obtained from the patients who were included in this study. In addition, they were reassured that any information collected would be kept confidential and only used for research purposes. The informed consent process ensured that participants had a full understanding of the study and could make an informed decision about whether to take part. Furthermore, all data collected during the study was securely stored and were anonymized before being used in this study.

Eligibility Criteria for Ambulatory Robotic Colorectal Surgery

We have set certain patient and procedure-specific eligibility criteria for ARCS. Eligible patients must be <80 years old and have a body mass index (BMI) <35 with an American Society of Anaesthesiologists (ASA) of 1 or 2 physical status score. Minimal or no previous abdominal surgery, not on anticoagulation or antiplatelet medications. Eligible procedures include elective robotic colonic resections (left sided, right sided) for colorectal cancer. In addition to meeting eligibility criteria for the surgery, patients must also have a social support network upon discharge from hospital.

Exclusion Criteria for Robotic Ambulatory Robotic Colorectal Surgery

Patients who met any of the following exclusion criteria were not considered for ARCS; emergency operations, conversion to open procedure and creation of a stoma, diabetes mellitus, previous pelvic radiotherapy, complex frailty requiring multi modal interventions. In addition, living alone upon discharge, being a nursing or residential home resident, inability to take medication independently or with help from relatives/carers; cognitive impairment limiting the ability to use home monitoring or undertake telephone/video calls or follow-up an escalation pathway.

Pre-Operative Care and Admission

The admission and pre-operative process is an important part of the overall surgical experience for the patient. The purpose of this stage was to ensure that all necessary steps were taken to prepare the patient for surgery, reduce the risk of complications, and provide them with information about their procedure and manage the patient expectations in the postoperative period which is paramount in the recovery journey. This includes an in-person pre-operative examination and consultation with the operative surgeon, a face-to-face anaesthetic assessment, and pre-operative education regarding nutritional supplementation, oral intake pre and post-operatively. It also involved explaining the benefits and risks associated with the surgical intervention as well as confirming social support and understanding of pain control, and escalation pathways. The virtual ward team also ensured that the patients were adequately prepared for their post-operative process. All three patients were supplied pre-hospital admission with monitoring kits and instructed on how to use them to check vital signs such as temperature, respiratory rate, heart rate and blood pressure. This was done in order to monitor the patient's recovery post-operatively. Additionally, colorectal specialist nurses provided emotional support and education to help alleviate anxiety associated with the upcoming surgical procedure.

Intra-Operative Care

The intra-operative care given during the peri-operative period was guided by enhanced recovery guidelines, which focused on optimal pain, glucose and temperature control as well as adequate fluid management. In addition, the use of nasogastric tubes, intra-abdominal drains were avoided and early removal of urinary catheters at the end of the procedure. Minimally invasive techniques were utilised. All surgical cases were assessed intra-operatively for their suitability for ambulatory care (uncomplicated procedures with a low risk of post-operative complications). This assessment also encompassed patient characteristics such as age, weight and past medical history.

Post-Operative Care and Discharge

Post-operative care and discharge post-operatively is a critical

component of ARCS management. It involved the early commencement of oral intake and analgesia, as well as early mobilisation. Vital signs, pain score, and urine output were monitored regularly in order to ensure that patients were recovering properly. The responsible consultant reviewed patients in the evening post-operatively. Furthermore, patients were taught how to administer their subcutaneous venous thromboembolism prophylaxis correctly. On the first post-operative period, key parameters such as patients' pain control, vital signs, blood results, clinical assessment and mobility were reviewed by a surgical team led by the responsible consultant during the ward round. Post-operative instructions were clearly communicated to patients, and they made aware of any potential post-operative complications (such as vomiting, abdominal distension, rectal bleeding) to enable them to early recognize the signs and symptoms of these complications if they occur. In addition, they were provided with an escalation pathway if post-operative concerns arise. The post-operative monitoring period was carried out using remote monitoring equipment's which were supplied to the patients by the virtual ward team pre-operatively. Both the virtual ward team and the surgical team had access to it. The virtual ward team as well as the colorectal surgical consultants spoke to the patients on daily bases and at day three formal monitoring was stopped.

Results

Patient and procedure characteristics are shown in Table 1. All the three ARCS procedures were completed robotically, without conversion to open or laparoscopic surgery. All three patients were discharged within 23 hours of their respective admissions and within 17 hours of their procedures. At 30-day follow up, none of the patients reported any complications (surgical site infection, rectal bleeding, anastomotic leak or ileus) in the post-operative period and there were no hospital re-admissions during this period. The post-operative histology showed clear margins and two out of three patients had N1 disease as detailed in Table 1. The expedite post-operative discharge and recovery allowed the commencement of adjuvant chemotherapy for both patients within less than a month post-operatively. In addition, the feedback from the patients regarding their peri-operative and virtual ward care post-operatively was overwhelmingly positive. They reported feeling comforted and supported by the nursing staff, as well as satisfied with the level of communication between themselves, the virtual ward team and the colorectal surgical consultants.

Table 1: Patient and procedure characteristics.

Patient	Age	Gender	BMI	Co-morbidities	ASA	Pre-operative staging and diagnosis	Surgery	Post op histology
1	56	Male	23	Migraines	2	Distal sigmoid adenocarcinoma T3N2M0	High anterior resection	Distal sigmoid adenocarcinoma pT3N2b(8/20)M0
2	51	Female	25	Arthritis	2	sigmoid adenocarcinoma T2N0M0	High anterior resection	Proximal sigmoid adenocarcinoma pT2N1a(1/25)M0
3	64	Male	28	Previous inguinal hernia repair	2	Distal sigmoid adenocarcinoma T3N1M0	High anterior resection	Distal sigmoid adenocarcinoma pT3N0(0/15)M0

Discussion

The ERAS program is a multidisciplinary approach to the treatment of surgical patients. This approach aims to reduce post-operative morbidity and mortality by developing standardized protocols and guidelines for early mobilization, nutrition, pain management, and other modalities [8-11]. ERAS programs for colorectal surgery have been shown to be effective in decreasing length of hospital stay and time to return to normal activity, as well as reducing complications and re-admission rates compared with standard care [23-25]. The improvement in robotic colorectal surgery and ERAS protocol has had a significant impact on the hospital patient experience and reducing the length of hospital stay [10,26]. The endpoint for this shortening of inpatient stay is ARCS which is increasingly being adopted in surgical practice due to its reported advantages of improved outcomes and reduced hospital costs [23-25]. Although early adopters have demonstrated favourable results, ARCS presents considerable challenge in terms of patient safety. Patients for this pathway need to be carefully selected with strict inclusion and exclusion criteria as well as strict post-operative pathway and re-admission criteria [18,19,21,27-30]. In our study, we were able to demonstrate the feasibility and safety of ARCS. This was achieved by implementing ERAS protocol throughout the peri-operative period in selective patients and with the help of two important innovations: robotic surgery and the virtual ward. Robotic surgery had a great impact on patient recovery post-operatively, resulting in faster recoveries and successfully discharging the three

patients within 23 hours of hospital admission. In addition, virtual ward enabled real-time communication between patients, surgeons, and virtual ward team to ensure optimal post-operative care. The eligibility criteria in our study for ARCS were strictly enforced in order to ensure successful outcomes and optimal patient safety. The inclusion and exclusion criteria used in our study were similar to those of previously published studies [18-21,28-30]. This will help to promote replicability and reliability, as well as enabling more meaningful interpretation of our data.

The admission and pre-operative process was an essential component of the patient's surgical experience, designed to ensure that all necessary steps had been taken prior to surgery. The purpose of this stage was to reduce the risk of complications and provide patients with the information they needed about their procedure. The use of evidence-based practices and protocols was an essential component in the intra-operative care provided during the perioperative period. The practice included enhanced recovery pathways and minimal invasive surgery techniques. We believe the use of evidence-based practices during intra-operative care helped in preventing post-operative complications and improved overall patient outcomes. This is indicative that adhering to evidence-based protocols and guidelines can help enhance patient safety and quality of care within the perioperative setting. Given these facts, healthcare providers should continue to strive for compliance with current evidence- based protocols in order to ensure optimal clinical outcomes for all patients undergoing ambulatory robotic colectomies. Patients were monitored closely during the peri-operative period to ensure that they experienced a safe and comfortable recovery. The team of anaesthesiologists, surgeons, and nurses worked together to ensure safe recovery for all patients undergoing ARCS procedures. It is essential that the healthcare professionals involved in the patient care have a thorough understanding of the goals and expectations during the patient's journey through this process. We believe that patients play a key role in this process and should understand their diagnosis, procedure and expected outcomes of care. Eligible patients must demonstrate readiness for discharge on the day after surgery. The post-operative care provided to our patients was comprehensive and focused on ensuring safe transition back home. The combination of appropriate home monitoring equipment, education, clear escalation pathway and virtual follow-up provided them with the necessary support required for a successful recovery.

This attention to detail in the post-operative care has resulted in safe transition of all our patients back home successfully. The virtual monitoring kits allowed for the virtual ward team and the colorectal surgical consultants to have remote access to patient observations, including blood pressure temperature, and heart rate. This enabled the virtual ward team and the colorectal surgical consultants to closely monitor patients' progress. The virtual post-operative call with the colorectal surgeon consultant provided an opportunity to quickly and accurately assess any changes in the recovery process or any other issues that may have arisen. Furthermore, the daily communication with patients allowed for any potential health problems to be identified and addressed promptly. This proved to be an effective way of assessing patient progress and ensuring a successful recovery from surgery. In addition, the use of the virtual monitoring kits enabled patients to return home safely and confidently, as they were able to be monitored while they recovered. This allowed for a more comfortable and efficient recovery, as well as eliminating the need for unnecessary hospital visits. Overall, this strategy of using virtual monitoring kits proved to be beneficial for both patients and clinicians, providing a cost-effective and safe way of monitoring post-operative progress. This study has several limitations. The sample size is small (three patients) and selected patients who do not reflect the general cohort. However, our initial experience demonstrates the safety and feasibility in performing ARCS and it is a viable option for those selected patients. Short-term outcomes and follow-up were observed for 30 days post-surgery only. However, no complications nor re-admission were reported during this limited period.

Ambulatory robotic colectomies for colorectal cancer are a relatively new technology, and so far, there is limited evidence for their efficacy and safety. Further research is needed to evaluate the feasibility of ambulatory robotic colectomies, with an emphasis on refining protocols to ensure patient safety. It is possible that this could provide an improved quality of care for patients and lead to cost savings for health care organisations. Systematic reviews should be conducted to examine current evidence regarding ambulatory robotic colectomies, identify gaps in knowledge, and suggest future directions for research. Such work will help inform clinical decision-making around the suitability of utilising ARCS. In addition, further economic analyses should be conducted to assess the true cost-effectiveness of robotic colectomies in ambulatory settings. This will help ensure that patients receive the best quality of care possible and that health care organisations are able to efficiently and cost-effectively manage their resources.

Conclusion

Our study results demonstrate the potential for ARCS as a feasible and safe option for selected patients undergoing colorectal surgery. Future studies are needed to further elucidate the safety and efficacy of this technique in larger patient populations. To our knowledge, this is the first report of ambulatory robotic colorectal surgery in the United Kingdom.

Statements and Declarations

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Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

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