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ORIGINAL ARTICLE

Robotic versus laparoscopic colorectal surgery in elderly patients in terms of recovery time: a monocentric experience

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Abstract

Colorectal cancer has a great socio-sanitary relevance. It represents the third cancer by incidence and mortality. Ageing plays a major role in the development of colorectal cancer and this tumour, in patients aged 65 and older, has gradually increased over the past decade. The robotic technique is considered the evolution of conventional laparoscopy. Few studies evaluate the effects of robotic surgery in elderly patient, and even fewer are those that compare it with laparoscopic surgery in this population. The aim of this study was to evaluate the perioperative outcomes of robotic colorectal surgery compared to laparoscopic colorectal surgery in patients older than 65 years. We conducted a retrospective study enrolling 83 elderly patients (age > 65) undergoing robotic and laparoscopic colectomy (32 and 51, respectively) between January 2019 and January 2021. For statistical analysis, p values were calculated using t test and chi-square test. $p < 0.05$ is the criterion for statistical significance. Statistical analyses were performed with the Number Cruncher Statistical System (NCSS) 2020 data analysis version 20.0.1 (Utah, USA). The operation time was higher in robotic left ($p = 0.003$, mean time 249.6 vs 211.7 min) and right ($p = 0.004$, mean time 238.5 vs 183.5 min) hemicolectomy and similar for procedures on rectosigmoid and rectum when compared to laparoscopic technique. In terms of length of hospital stay and recovery of bowel function, these values were significantly lower for robotic group in left hemicolectomy ($p = 0.004$), rectum ($p = 0.003$) and rectosigmoid ($p = 0.003$), while right hemicolectomy was similar in two groups ($p = 0.26$). There was no statistically significant difference between the groups regarding conversion rate, postoperative complications, length of specimen, number of lymph nodes encountered and oncological results. Colorectal robotic surgery in elderly patients appears as a feasible and safe surgical approach when compared to the laparoscopic one, showing a shorter recovery and a reduction of length of stay with similar oncological outcomes even if with an increase of operating times.

Keywords Colorectal surgery · Colorectal cancer · Laparoscopic surgery · Robotic surgery · Oncology surgery · Elderly

Introduction

Colorectal cancer has a great socio-sanitary relevance. In the worldwide, it is the third cancer in terms of incidence and mortality, after breast and lung or bronchus cancer in women and prostate and lung or bronchus cancer in men [1, 2]. The incidence in Italy in 2020 has been estimated to be around 45,000 new cases (24,000 in men and 21,000 in women) [3]. Ageing plays a major role in the development of colorectal cancer and this tumour, in patients aged 65 and older, has gradually increased over the past decade [4, 5]. Approximately 90% of new cases are diagnosed in patients older than 50 years and 60% of whom are > 65 years old [6]. Colorectal cancer prognosis improved due to early diagnosis and changes in clinical management. During the last 20 years, there has been an increase in 5-year survival rates, especially for patients with advanced tumours [7]. The first laparoscopic colectomy was described by Jacobs in 1991 [8]. Minimally invasive colorectal surgery has many advantages: small incisions, better aesthetic results, less postoperative pain, faster intestinal function recovery, shorter hospital stays, lower postoperative mortality and morbidity with similar oncological outcome compared to open surgery [9, 10]. However, laparoscopy has some intrinsic limitations such as two-dimensional (2D) visualization, reduced ergonomics

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in confined spaces, tremor effect and possible incoordination between the surgeon's eye and hand. [11, 12]. Laparoscopy is safe and feasible for colorectal cancer surgery in the elderly and beyond these benefits described, also has improved short-term postoperative outcome more in elderly than in younger patients [13–15].

The robotic technique was developed as the evolution of conventional laparoscopy [1, 7, 11]. Robotic surgery provides several advantages such as three-dimensional (3D) high-definition vision, greater freedom and control on operating instruments, flexible wrists, and filtration of hand tremor to improve maneuverability and operative comfort [8, 11, 12, 16, 17]. The robotic technique for colorectal surgery was introduced in 2002 by Weber [18]. Over the years, it has increased significantly, and many authors have begun to approach robotically to elderly patients too (age 65 years) [19, 20]. In urology, many studies showed robotic surgery for prostate cancer safe in elderly patients, while role in general surgery remains unclear [21].

There are several studies comparing robotic and laparoscopic colorectal surgery but few focus on the elderly patient. The aim of this study was to evaluate the perioperative outcomes of robotic colorectal surgery compared to laparoscopic colorectal surgery in patients older than 65 years.

Materials and methods

This is a retrospective observational study enrolling patients with colorectal cancer older than 65 years undergoing robotic and laparoscopic surgery at the Surgery Unit of the University Hospital Federico II of Naples from January 2019 to January 2021. Two senior general and colorectal surgeons, with 5 years of experience in robotic surgery and at last 10 year in colorectal surgery, performed all procedures. These surgeons have an annual volume of at least 40 cases for each robotic and laparoscopic colorectal surgery.

Patients were assigned to two group: laparoscopic and robotic. The two groups were further divided, according to the tumor location, into right-sided, left-sided, rectosigmoid and rectum carcinoma.

From database of our unit, the following patient data was collected retrospectively: age, sex, body mass index (BMI), American Society of Anesthesiology (ASA) score and indication for surgery. The following perioperative outcomes were analyzed: operative time (in minutes), time for bowel function recovery (in days), length of stay (in days), length of specimen (in centimeters), intraoperative or postoperative complications (based on Clavien-Dindo classification) and number of lymph nodes removed [22]. All patients underwent a preoperative colonoscopy and total body computed tomography for preoperative staging. Additionally, patients with rectum involvement underwent MRI (magnetic resonance imaging) for further staging. All rectal carcinomas underwent neoadjuvant therapy before surgery. The following exclusion criteria have been applied: presence of metastasis or peritoneal carcinosis detected during exploratory laparoscopy, BMI > 30, ASA 4, extracorporeal anastomosis, synchronous cancers of the colon or the rectum, benign disease and procedures performed during emergency surgery. Venous thromboembolism prophylaxis, perioperative management of antiplatelet and anticoagulant therapy and antibiotic prophylaxis were set up according to literature [23–25]. For statistical analysis, p values were calculated using t test and chi-square test. $p < 0.05$ is the criterion for statistical significance. Statistical analyses were performed with the Number Cruncher Statistical System (NCSS) 2020 data analysis version 20.0.1 (Utah, USA). The study was performed in accordance with the principles of the Declaration of Helsinki and its appendices. Approval was obtained from the Institutional Review Board and Ethics Committee.

Results

Out of a total of 195 patients underwent elective laparoscopic ($n = 116$) or robotics ($n = 79$) surgery for colorectal cancer between 1 January 2019 and 1 January 2021, we enrolled 83 patients older than 65 years (32 treated with robotic and 51 with laparoscopic surgery). In particular, the robotic group (RG) included 7 patients with left-sided colon carcinoma, 3 with rectosigmoid carcinoma, 12 with rectum carcinoma and 10 with right-sided colon carcinoma, while the laparoscopic group (LG) included 15 patients with left-side colon carcinoma, 3 with rectosigmoid carcinoma, 9 with rectum carcinoma and 24 with right-sided colon carcinoma. Table 1 contains patients' stratification by age, sex, BMI, and ASA score. For these clinical characteristics, there were no statistically significant differences.

Table 1 Clinical characteristics of enrolled patients ($n = 83$)

Sex	
Male: 50 (60, 2%)	Robotic: 19 Laparoscopic: 31
Female: 33 (39, 75%)	Robotic: 13 Laparoscopic: 20
Age (mean)	
Male: 73, 7	Female: 75, 25
ASA score	
ASA 2: 43 (53, 08%)	Robotic (18): 21,6% Laparoscopic (25): 30,2%
ASA 3: 40 (46, 91%)	Robotic (14): 16,9% Laparoscopic (26): 31,3%

Operative outcomes

Operative time was significantly higher in robotic group compared to laparoscopic group (266, 78 ± 60, 22 min for RG vs 232, 29 ± 54, 90 min for LG; $p < 0.05$). In details, concerning the robotic group, operative time was higher for left ($p = 0.003$, mean time 249.6 vs 211.7 min) and right hemicolectomy ($p = 0.004$, mean time 238.5 vs 183.5 min), and similar for procedures on rectosigmoid ($p = 0.87$) and rectum ($p = 0.12$) when compared to laparoscopic technique (Table 2).

In robotic group, only one procedure (rectum) was converted to open surgery because of bleeding during the procedure, while in laparoscopy seven procedures were converted for bleeding (two left hemicolectomies, three right and two rectum) without a statistically significant difference ($p = 0.345$). In right hemicolectomy, we have used abdominal drain only in a few selected cases: four patients in laparoscopic group and four patients in robotic group. Moderate blood loss and patient comorbidities were the criteria for abdominal drainage positioning.

Table 2 Univariate analysis of the identified perioperative outcomes

	Laparoscopic	Robotic	*p*
Conversion	7 (13,7%)	1 (3,1%)	0,35
Complication	15 (29,4%)	8 (25%)	0,66
•Grade I	11	6	
•Grade II	2	1	
•Grade III	2 (IIIb)	1 (IIIb)	
Operation time (minutes)			
•Left side	211.7	249,6	0,003
•Right side	183,5	238,5	0,004
•Rectum	291,7	302,8	0,12
•Rectosigmoid	270	276	0,87
Mean recovery of bowel function (days)			
•Left side	3,6	2,6	0,004
•Right side	3	3,1	0,98
•Rectum	1,6	1,1	0,004
•Rectosigmoid	2,7	1,5	0,003
Mean of length of stay (days)			
•Left side	5,8	4,2	0,004
•Right side	6,3	6,6	0,26
•Rectum	7,1	5	0,003
•Rectosigmoid	6,2	3,7	0,003
Mean number of lymphonodes			
•Left side	16,7	21,5	0,18
•Right side	20,4	19,2	0,94
•Rectum	14	23,7	0,12
•Rectosigmoid	21,6	17,3	0,53
Mean length of specimen (cm)			
•Left side	21,5	27,6	0,19
•Right side	26,8	31	0,34
•Rectum	26,3	22,9	0,22
•Rectosigmoid	24,8	32,6	0,11

Postoperative outcomes

Time to bowel function recovery was significantly lower for robotic group in left hemicolectomy ($p = 0.004$), rectum resection ($p = 0.004$) and rectosigmoid resection ($p = 0.003$), but there was no statistically significant difference in right hemicolectomy ($p = 0.98$), (Table 2).

In terms of length of hospital stay, it was significantly lower for robotic group in left hemicolectomy ($p = 0.004$), rectum resection ($p = 0.003$) and rectosigmoid resection ($p = 0.003$), while right hemicolectomy was similar in two groups ($p = 0.26$) (Table 2).

The number of lymph nodes excised was not statistically significant between the two techniques. In terms of length of specimen, there were no statistically significant differences between the two techniques (Table 2).

Postoperative complications

Complications occurred in 15 patients of laparoscopic group and 8 patients of robotic group without statistically significant difference ($p = 0.66$). In detail, according to Clavien-Dindo classification, one grade I complication (fever) was detected for patients undergoing robotic left hemicolectomy, while in patients treated with laparoscopy, we observed five grade I complications (two fever, two nausea and one vomiting) and one grade IIIb (anastomotic leakage). For right hemicolectomy, four grade I complications (two fever, one nausea and one headache), one grade II (transfusion) and one grade IIIb (occlusion) were observed in robotic group, while five grade I (three fever, one nausea and one headache), two grade II (wound infection) and one grade IIIb (anastomotic leakage) were observed in laparoscopic group. For rectum surgery, two grade I complications (one fever and nausea, respectively) were observed in both robotic and laparoscopic groups. For rectosigmoid surgery, no complications were detected in both groups. Three patients needed reintervention, two for laparoscopic group and one for robotic group.

Discussion

Colorectal cancer is one of the most common tumors in the world, especially in elderly people [2–6]. The increase of elderly population makes this cancer a major socio-health problem [3–6]. Over the years, thanks to improvement of anesthesiology and surgical technologies, indications for major surgery have also been extended to the elderly population [19]. Several studies describe laparoscopic colorectal surgery in elderly patients as technically and oncologically safe compared to non-elderly, with similar results [19, 26]. Frasson et al. showed how laparoscopic colorectal resection improved short-term postoperative outcome more in elderly than in younger patients [13]. Zhou et al. compared laparoscopic and open colorectal surgery in elderly patients showing better results in short-term outcomes in the first group [27]. In this recent study, Keller et al. showed that laparoscopic surgery for colorectal cancer in the elderly, in addition to the clinical benefits, reduces overall costs in comparison to open surgery [15]. Robotic surgery was born to overcome the limits of laparoscopy (2-D vision, reduced ergonomics in confined spaces, tremor effect and unnatural hand–eye coordination) and was successfully applied to urology, general and pediatric surgery, gynaecology, and other surgical fields [11, 12, 17, 28, 29]. Robotic surgery has some advantages, such as shorter learning curve, 3-D views, increased wrist flexibility, better ergonomic benefits, reduction of hand tremor and surgeon workloads [8, 11, 12, 16, 17, 30]. Comparison between robotic and laparoscopic surgery is considered a "hot topic". Several studies suggested that robotic surgery is safe, feasible with same perioperative and oncological outcomes as laparoscopic surgery [17, 31–35]. A meta-analysis showed that both techniques had similar results, even if the benefits of robotic surgery for colorectal disease remain controversial [31]. Additionally, Liao et al. published a meta-analysis on data from randomized control trials (RCTs) showing reduced conversion rate, reduced blood loss and reduced recovery time in robotic surgery compared to laparoscopic surgery [32]. These authors found no differences in other analysed variables (operation time, complication rate and length of stay) [32]. Furthermore, many studies show that robotic surgery is associated with a significant increase in total costs and higher anaesthesiologic risks than the laparoscopic approach [31–35]. The role of robotic surgery in older patients remains unclear and there are still few studies about it. Buchs et al. evaluated feasibility, safety, and short-term outcomes of robotic surgery in elderly patients. These authors showed that robotic surgery can be performed with low mortality, acceptable morbidity, and short hospital stay [19]. Oldani et al. compared robotic surgery for colorectal cancer between elderly and younger patients showing that age alone cannot be considered an exclusion criterion for this approach even with high ASA score [20].

We have enrolled 83 elderly patients (age > 65) since 1 January 2019 to 1 January 2021. Our unit has an annual volume of 150 cases of robotic procedures for general surgery, and at least 60% of which for colorectal surgery. As part of COVID-19 containment strategy and with Intensive Care Unit (ICU) near collapse, there was a reduction in surgical procedures, including colorectal interventions also due to the decrease in endoscopic diagnoses [36, 37]. In this study, we compared laparoscopic and robotic colorectal surgery in elderly patients with colorectal cancer. In terms of operation time, we found significant difference between robotic and laparoscopic surgery for right and left colectomy; the mean operative time was respectively 249.6 min and 238.5 min in left and right robotic hemicolectomy and 211.7 min and 183.5 min in left and right laparoscopic hemicolectomy. Longer operating time may be due to the docking and setting of the robotic arms and instruments during surgery. Regarding operation time for rectal and rectosigmoid surgery, we did not find significant differences. This interesting aspect may be due to a better vision of pelvis in robotic surgery that allows an improved and rapid dissection [38, 39], compensating the timing of docking and instruments setting. Deutsch et al. showed the usefulness of the robotic approach during rectal and low-rectal procedures, where dissection and surgery is extremely difficult and dangerous for surgeon [38].

TME technique for rectal cancer, as described by Heald et al. will theoretically reduce injury to the pelvic autonomic nerves [40]. Nevertheless, previous studies showed that urinary and sexual dysfunction is a serious complication after rectal cancer surgery [35, 39, 41]. In a prospective study published on 2016, Wang et al. were included 137 female and 336 male patients who underwent surgery for rectal cancer; these authors confirmed more accuracy in robotic TME versus laparoscopic TME due to a magnified image and to a best view of the connective tissue between the parietal and visceral fascia [39]. Moreover, in according to Kim MJ et al., they showed that robotic TME has superior visualization, increased manoeuvre capacity and stable surgeon-controlled robotic instruments that may lead to less tissue trauma, preventing vascular injuries and nerves injuries [39, 42]. However, studies of postoperative urinary and sexual function in robotic rectal cancer surgery are limited [39, 41]. For the TME surgery in elderly patients, Su et al. in their study showed how robot-assisted surgery for rectal cancer was safe and well tolerated by these populations with similar results to the younger [43].

Kulaylat et al. and Bhama et al. compared the outcomes of non-emergent laparoscopic and robotic colorectal surgery proving that robotic approach was associated with similar results in term of postoperative morbidity but decreased conversion rates and shorter length of stay [44, 45]. The Robotic versus Laparoscopic Resection for Rectal Cancer (ROLARR) randomized clinical trial compared the conversion rate to open laparotomy in robotic (8,1%) versus conventional laparoscopic rectal surgery (12,2%) demonstrating a non-significantly reduced risk of conversion rate for robotic surgery [31, 44–47]. Our results, although concern elderly patients, were in line with these last ones, with a conversion rate of 3,1% in robotic surgery versus 13.7% in laparoscopic surgery ($p = 0.35$). As already reported in literature, regardless of age, we did not demonstrate a statistically significative difference between the two techniques in terms of post-operative complications (29,4% laparoscopy vs 25% robotic; $p = 0.69$) [31, 35, 41, 46, 47].

In literature, there are few studies that evaluate the effects of robotic surgery in the elderly patient, even fewer are those that compare with laparoscopic surgery. We only found one study that compared robotic colorectal resection surgery versus laparoscopic colorectal resection surgery in elderly patients [48]. In this retrospective study, there are similar results between the two approaches in terms of operative and oncologic outcomes, despite longer operative times for the robotic surgery [48]. Unlike previous studies, we considered surgeons with a proven track record in both robotic and laparoscopic surgery. In our study, operative time was higher for left and right hemicolectomy but, in terms of recovery time and length of stay, there was a statistically significant reduction for left hemicolectomies, rectosigmoid resections and rectum resections in robotic groups compared with laparoscopic group. The reduction of length of stay is reported also by comparative study of Al-Mazrou et al. [49]. These authors, enrolled 2482 cases eligible for propensity score-matched analysis, showing that RC is associated with some recovery benefits over LC [47]. A case-matched of American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) comparing 12,790 patients showed a better LOS (length of stay) in robotic colorectal surgery versus laparoscopic colorectal surgery but with a high operative cost [49]. There are other studies that report a reduction in hospitalization after robotic colorectal surgery, but no one targets elderly patients [17, 43, 44, 49–53].

Enhanced Recovery After Surgery (ERAS) is a protocol for optimal perioperative care to reduce physiological stress, to maintain postoperative physiological function and to accelerate recovery after surgery [54]. Liu et al. showed that ERAS protocol can be applied successfully to elderly patients undergoing colorectal surgery [55]. Joris et al. comparing ERAS protocols between younger and elderly patients, reported not only safety and feasibility in seniors, but also similar benefits [56]. We apply the ERAS protocol to all patients, regardless of age, undergoing elective colorectal surgery with excellent results. In our opinion, this approach, associated with a shorter hospital stay, is very important for a rapid recovery in elderly patients.

As the elderly population increases, it is important to evaluate the use of robotic surgery in this patient population. We are surprised that the literature is still too scarce, so our study aims to turn the spotlight on this aspect. We hope that our study will prompt other authors to verify the importance of robotic surgery in recovery in the elderly.

Limitations

Some limitations must be addressed. The most important are the retrospective nature of the study and the non-randomization of groups which could hide potential bias such as patients' selection and choice of surgical procedure. Furthermore, another limitation is the few cases recruited; this is due to the small number of surgeons skilled in robotic approach in our center: in facts, only two surgeons have the adequate experience in this field; moreover, the Covid-19 pandemic had an obvious negative impact on surgical activity. Randomized trials should be conducted to evaluate the real benefits in relation to both costs and perioperative outcomes in elderly patients.

Conclusion

Our study shows that robotic colorectal surgery is characterized by better recovery, reduced mobilization time, and shorter length of hospital stay when compared to the laparoscopic approach in elderly patients. Considering our analysis a proof of concept, further studies are needed to confirm our results.

Author contributions GP: conception and design of study, interpretation of data, writing and final approval of the paper. VPD: writing and final approval. MC and PA: acquisition of data and final approval of the paper. MM: conception and design and final approval of the paper. GDDP: conception and design of study and final approval of the paper. GA: conception and design of study, critical revision and final approval of the paper.

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Declarations

Conflict of interest No personal or financial conflicts of interest for all the authors. Giuseppe Palomba, Vincenza Paola Dinuzzi, Marianna Capuano, Pietro Anoldo, Giovanni Aprea, Giovanni Domenico De Palma declared that they have no conflict of interest.

Ethical approval The study was approved by the local ethical committee.

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