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Robotic versus laparoscopic right colectomy with intracorporeal anastomosis: a multicenter comparative analysis on short-term outcomes

Leonardo Solaini[1,2] · Davide Cavaliere[1] · Francesca Pecchini[4] · Federico Perna[3] · Francesca Bazzocchi[1] · Andrea Avanzolini[1] · Domenico Marchi[4] · Paolo Checcacci[3] · Alessandro Cucchetti[1,2] · Andrea Coratti[3] · Micaela Piccoli[4] · Giorgio Ercolani[1,2]

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Abstract

Background In literature, most of the comparative studies of robotic (RRC) versus laparoscopic (LRC) right colectomy are biased by the type of the anastomotic technique adopted. With this study, we aim to understand whether there is a role for robotics in performing right colectomies, comparing RRC versus LRC, both performed with intracorporeal anastomosis.

Methods In this retrospective cohort study, all consecutive patients who underwent minimally invasive right colectomy (robotic or laparoscopic) with intracorporeal anastomosis in three Italian high-volume centers between February 1, 2007 and December 31, 2017 were included. Patients were grouped according to the method of surgery: RRC or LRC.

Results A total of 389 patients were included in the study (305 RRC vs. 84 LRC). Patients' baseline characteristics were comparable between the groups. Operative time was significantly longer in RRC (250 min, IQR 209–305) group than LRC group (160 min, IQR 130–200) ($p < 0.001$). The median number of lymph nodes harvested was 22 (IQR 18–29) in RRC group while it was 19 (IQR 15–27) in LRC one ($p = 0.028$). No significant differences between the groups were seen in terms of time-to-first flatus, postoperative complications and length of hospital stay. Re-admission rate was significantly higher in LRC ($n = 3$, 3.6%) group than in RRC group ($n = 1$, 0.3%) ($p = 0.033$).

Conclusions In conclusion, RRC and LRC are comparable in terms of functional postoperative outcomes and length of hospital stay. RRC requires longer operative time, but the number of lymph nodes harvested may be higher.

Keywords Robotic surgery · Minimally invasive right colectomy · Laparoscopy · Outcomes · Anastomosis

Minimally invasive right colectomy has been demonstrated to be safe and feasible [1, 2]. However, it is still unclear whether robotic right colectomy (RRC) could add real advantages in terms of outcomes when compared with laparoscopic right colectomy (LRC). It seems that RRC may be associated with a lower conversion rate and a shorter time-to-first flatus resulting in a decreased length of hospital stay. However, a recent metanalysis showed that those advantages might be just correlated to the rate of intracorporeal anastomosis which is significantly more common during RRC [3]. To date, most of the published papers [4–7] on the comparison between RRC and LRC presented groups which were not comparable in terms of the anastomotic technique used and this produced results difficult to interpret. Others reported outcomes only on right colectomies performed with extracorporeal anastomosis [8–12].

With this paper, we aim to understand whether there is a role for robotics in performing right colectomies, comparing RRC versus LRC performed with intracorporeal anastomosis.

✉ Leonardo Solaini
leonardo.solaini2@unibo.it

1 General and Oncologic Surgery, Morgagni-Pierantoni Hospital, Ausl Romagna, Forlì, Italy

2 Department of Medical and Surgical Sciences (DIMEC), University of Bologna, Bologna, Italy

3 Division of Oncological and Robotic General Surgery, Careggi University Hospital, Florence, Italy

4 Division of General, Emergency Surgery and New Technologies, OCSAE (Ospedale Civile Sant'Agostino Estense), Baggiovara, Modena, Italy

Materials and methods

This study was performed according to the Strengthening the Reporting of Cohort Studies in Surgery (STROCSS) guidelines [13].

Study design and patients

In this retrospective cohort study, all consecutive patients who underwent minimally invasive right colectomy (robotic or laparoscopic) with intracorporeal anastomosis in three Italian high-volume centers between February 1, 2007 and December 31, 2017 were included. Patients were grouped according to the method of surgery: RRC or LRC.

All procedures were conducted in accordance with the ethical standards of the respective committees on human experimentation (institutional and national) and with the Helsinki Declaration of 1964 and later versions. The risks and benefits of the procedure were presented to the patients and written informed consent was obtained prior to providing the treatment.

Variables and definitions

Baseline characteristics collected included sex, age, American Society of Anesthesiologists (ASA) score, BMI, indication for surgery (neoplasm versus benign). Operative variables collected included operative time, conversion to open surgery, intraoperative blood loss, and additional resection. Postoperative outcomes were postoperative complications and mortality, type of complication, re-admissions within 90 days from discharge, time to first flatus, time to oral feeding, and length of hospital stay. Complications, which were graded as proposed by Clavien and coworkers [14], were recorded up to 90 days after the procedure. Anastomotic leak was defined as a radiologically proven defect of the intestinal wall at the anastomotic site. Abdominal abscess was an infected intraabdominal collection in the absence of an anastomotic leak. Wound infection was defined as a wound requiring partial or complete opening for drainage of purulent collection. Postoperative hemorrhage was defined as hemorrhage requiring intervention or blood transfusion.

Statistical analysis

Continuous data were presented as median and interquartile range and were compared using Mann–Whitney *U* test. Categorical data were presented as number and percentages and compared with chi-squared test or Fisher exact test when appropriate. A p value < 0.05 was considered statistically significant. MedCalc Statistical Software version 15.8 (MedCalc Software bvba, Ostend, Belgium; https://www.medcalc.org; 2015) was used to analyze the data.

Results

A total of 389 patients were included in the study (305 RRC vs. 84 LRC). Patients' baseline characteristics were comparable between the groups and are presented in Table 1. Operative outcomes are reported in Table 2. Operative time was significantly longer in RRC (250 min, IQR 209–305) group than LRC group (160 min, IQR 130–200) ($p < 0.001$). The median number of lymph nodes harvested was 22 (IQR 18–29) in RRC group while it was 19 (IQR 15–27) in LRC one ($p = 0.028$). Postoperative outcomes are shown in Table 3. No significant differences between the groups were seen in terms of postoperative complications. Re-admission rate was significantly higher in LRC ($n = 3$, 3.6%) group than in RRC group ($n = 1$, 0.3%) ($p = 0.033$).

In the subgroup of right colectomies performed for malignant tumors ($n = 333$), a median of 23 (IQR 18–29) lymph nodes were harvested during RRC versus 19 (IQR 15–27) during LRC ($p = 0.044$). In the same subgroup of patients, one case of microscopically positive resection margin was registered in RRC group (0.4%) while no cases were found in LRC group ($p = 1.000$).

Table 1 Baseline characteristics

Variables *n* (%)	Robotic ($n = 305$)	Laparoscopic ($n = 84$)	*p*
Age			
≥ 65	209 (68.5)	59 (70.2)	0.792
< 65	96 (31.5)	25 (29.7)	
Sex			
F	142 (46.5)	45 (53.6)	0.269
M	163 (53.5)	39 (46.4)	
BMI			
≥ 30	44 (14.4)	7 (8.3)	0.199
< 30	261 (85.6)	77 (91.7)	
ASA score			
> 2	69 (22.6)	20 (23.8)	0.883
≤ 2	236 (77.4)	64 (76.2)	
Neoplasm			
Yes	260 (85.2)	74 (88.1)	0.597
No	45 (14.7)	10 (11.9)	

Table 2 Operative outcomes

Variables	Robotic ($n=305$)	Laparoscopic ($n=84$)	p
Operative time (min)—median—(IQR)	250 (209–305)	160 (130–200)	< 0.001
Conversion to open surgery n (%)			
Yes	3 (1)	0 (0)	0.119
No	302 (99)	84 (100)	
Intraoperative blood loss ($n=170$)	50 (50–50)	50 (50–75)	0.876
Additional resection n (%)			
Yes	39 (12.8)	6 (71.4)	0.180
No	266 (87.2)	78 (92.8)	
Number of lymph node harvested (n)—median—(IQR)	22 (18–29)	19 (15–27)	0.028

Table 3 Postoperative outcomes

Variables	Robotic ($n=305$)	Laparoscopic ($n=84$)	p
Postoperative complications n (%)			
Yes	71 (23.3)	21 (25)	0.772
No	234 (76.7)	63 (75)	
Postoperative mortality n (%)			
Yes	1 (0.3)	2 (2.4)	0.119
No	304 (99.7)	82 (87.6)	
Postoperative complications Clavien–Dindo > 2 n (%)			
Yes	19 (6.2)	7 (8.3)	0.467
No	286 (93.8)	77 (91.7)	
Anastomotic leak n (%)			
Yes	8 (2.6)	3 (3.6)	0.709
No	297 (97.4)	81 (96.4)	
Wound infection n (%)			
Yes	21 (6.8)	6 (7.1)	1.000
No	284 (93.1)	78 (92.8)	
Abdominal abscess n (%)			
Yes	4 (1.3)	1 (1.2)	1.000
No	301 (98.7)	83 (98.8)	
Postoperative hemorrhage n (%)			
Yes	12 (3.9)	6 (7.1)	0.240
No	293 (96.1)	78 (92.9)	
Re-admissions ≤ 90 days n (%)			
Yes	1 (0.3)	3 (3.6)	0.033
No	304 (99.7)	81 (96.4)	
Time to first flatus (days)—median—(IQR)	3 (2–3)	2 (2–3)	0.062
Oral feeding (days)—median—(IQR)	3 (2–3)	2 (2–3)	0.269
Hospital stay (days)—median—(IQR)	7 (6–9)	8 (6–10)	0.137

Discussion

Postoperative outcomes of RRC and LRC performed with intracorporeal anastomosis are comparable. To date, only Trastulli et al. [15], in a cohort of 142 patients, compared RRC versus LRC performed with intracorporeal anastomosis. In their study, the authors found that postoperative outcomes were similar between the groups who had the same anastomotic technique. In particular, RRC and LRC were comparable in terms of complications and length of

hospital stay, but time-to-first flatus was still significantly shorter in RRC group.

Other comparative studies reported heterogeneous groups not comparable with regard to the anastomotic technique adopted [4–7]: they reported postoperative outcomes in favor of RRC, with time to first flatus significantly shorter in this group of patients when compared with LRC. Those results were conflicting and difficult to compare as the apparent advantages could have been ascribed to the anastomotic technique used in each group rather than the type of approach. Recently, a metanalysis [3] demonstrated that the difference in postoperative outcomes was not found in the comparative studies considering LRC versus RRC both performed with extracorporeal anastomosis, suggesting the importance of the anastomotic technique in affecting the functional recovery after the procedure.

To our knowledge, this is the largest study about the comparison RRC versus LRC including in the analysis only intracorporeal anastomosis. As indirectly demonstrated by a recent metanalysis [3], we found that time to first flatus and time to oral feeding were comparable between the groups. In addition, our cohort showed an unbalance in terms of number of patients per each group. This is due to the fact that intracorporeal anastomosis, which requires advanced skills with the laparoscopic instruments, is much easier to be performed with the aid of the robotic wrists. As such, the use of the robotic platform in performing right colectomy could guarantee a higher rate of intracorporeal anastomosis and thus, a faster recovery. Furthermore, a metanalysis on laparoscopic right colectomies showed that intracorporeal anastomosis was associated with a lower morbidity rate than the extracorporeal one [16]. In light of this, the use of the robotic approach aiming to increase the number of intracorporeal anastomosis may be recommended.

Operative time was significantly longer in RRC group also in this cohort. This, which is in agreement with what has already been reported in the literature [3], could be due to the docking time which may prolong the duration of the procedure. In the present study, operative time might have been affected also by the learning curve effect which was demonstrated to affect outcomes of the first 44 RRC [17]. Still, the learning curve effect was present only in the RRC group as all surgeons were expert laparoscopic colorectal surgeons at the beginning of the study. It must be also considered that robotic surgery, providing higher dexterity and an extremely accurate view of the operating field, should lead to a meticulous dissection of tissues which is "different" from the standard laparoscopic surgery; all these technical aspects, which may be more in common with microsurgery than laparoscopy, might result in a type of dissection requiring a prolonged operative time. A large prospective study would answer to the question on which factors may affect operative time in RRCs.

RRCs were significantly associated with a higher number of lymph nodes harvested than LRC and this was confirmed also in the sub-analysis of patients who had undergone right colectomy for cancer. A metanalysis [3] found a trend towards statistical significance for a higher number of lymph node retrievals during RRC than LRC, but this analysis considered both benign and malignant diseases. In our opinion, the three-dimensional visualization and the seven degrees of freedom of the robotic wrists could allow a precise and delicate tissue dissection which may result in a more accurate lymphadenectomy.

This study has a few limitations mainly linked to its retrospective nature which exposed the results to be influenced by selection biases. In addition, we did not present data on costs of both procedures and we believe this aspect should not be underestimated when dealing with a very expensive tool such as the robotic system. To overcome these issue, a prospective observational study on the outcomes of LRC and RRC is currently ongoing at our institutions with the aim of investigating/confirming the role of robotics in colorectal surgery.

In conclusion, RRC and LRC are comparable in terms of functional postoperative outcomes and length of hospital stay. RRC requires longer operative time, but the number of lymph nodes harvested may be higher. Further prospective comparative analyses between homogenous groups are required to understand the real advantages of using robotics in performing right colectomies.

Compliance with ethical standards

Disclosures Leonardo Solaini, Davide Cavaliere, Francesca Pecchini, Federico Perna, Francesca Bazzocchi, Andrea Avanzolini, Domenico Marchi, Paolo Checcacci, Alessandro Cucchetti, Andrea Coratti, Micaela Piccoli, and Giorgio Ercolani have no conflicts of interest or financial ties to disclose.

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