Surgical Endoscopy (2019) 33:2583–2590
https://doi.org/10.1007/s00464-018-6553-x

Robotic pelvic dissection as surgical treatment of complicated diverticulitis in elective settings: a comparative study with fully laparoscopic procedure

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Received: 21 August 2018 / Accepted: 17 October 2018 / Published online: 7 November 2018

Abstract

Background Recently, minimally invasive treatment of complicated sigmoid diverticulitis is becoming a valid alternative to standard procedures. Robotic approach may be useful to allow more precise dissection in arduous pelvic dissection as in complicated diverticulitis. The aim of this study is to investigate effectiveness, potential benefits and short-term outcomes of robotic-assisted laparoscopic surgical resection, compared with fully laparoscopic resection in complicated diverticulitis.
Methods Between January 2009 and December 2017, 156 consecutive patients with history of complicated diverticular disease were referred to our Department of General, Mininvasive and Robotic Surgery. All patients underwent elective colonic resections performed by the same colorectal surgeon and followed a perioperative ERAS program. Demographic and clinical features, surgical data, postoperative data, 30-day morbidity and mortality, VAS for surgeon's compliance were evaluated.
Results One hundred and fifty-six consecutive patients underwent elective colonic resection: 92 fully laparoscopic (FL) colorectal resections and 64 procedures with robotic hybrid approach (RHA). Conversion rate was none in the RHA group versus 6.5% in the FL group, because of poor vision due to bowel distension, inflammatory pseudotumor and peritoneal adhesions. No 30-day mortality was observed. Mean operative time was 167.5 ± 54.4 min (80–420) in the FL group and 172.5 ± 55.64 min (110–325) in the RHA group (*p* 0.079), mean intraoperative blood loss was 144.6 ± 40.6 ml (40–200) with the FL technique and 138.4 ± 28.3 ml (20–185) with the RHA (*p* 0.295). Mean hospital stay for FL was 5 ± 4.1 days (range 3–45) and 5 ± 2.7 days (range 3–20) for RHA (*p* 0.974). Overall postoperative morbidity rate was 21.6% in the FL group and 12.3% in the RHA (*p* 0.067). Major postoperative morbidity (Clavien–Dindo 3 and 4) represented 13% and 4.6%, respectively (*p* 0.091). VAS for surgeon's compliance revealed a better performance in the robotic arm (*p* 0.059).
Conclusions This preliminary study highlights the potential benefits of robotic-assisted laparoscopy in colorectal resections for complicated diverticular disease in terms of surgical efficacy, postoperative morbidity and better surgeon's compliance.

Keywords Robotic resection · Complicated diverticulitis · Colorectal surgery · Minimally invasive surgery

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Background

In Western countries, the incidence of diverticular disease (DD) is slowly increasing, owing to the changing in lifestyle and the increased life-expectancy [1]. Around 10–25% of patients with known DD may suffer from complicated diverticulitis, and among them, 10–20% would need a surgical treatment, with a considerable financial and social impact on the society. For several authors, colorectal resection with primary anastomosis for complicated diverticular disease is considered a more challenging procedure than a colectomy for cancer, whether or not a laparoscopic or open approach is applied [2, 3].

Robotic-assisted laparoscopic surgery has recently gained popularity in the treatment of colorectal cancer and endometriosis. However, there are only few papers reporting its application in the field of diverticular disease, mostly regarding a limited number of patients [4–6].

The aim of this study was to investigate effectiveness, benefits and short-term clinical outcomes of robotic-assisted laparoscopic surgical resection compared with fully laparoscopic resection in complicated diverticular disease.

Methods

Patients selection

Between January 2009 and December 2017, 210 patients were admitted to the Department of General, Mininvasive and Robotic Surgery of Abano Terme Hospital (Padova) for elective treatment of complicated diverticular disease. Among them, 156 consecutive patients were treated with an elective colorectal resection with primary anastomosis with or without stoma protection.

Ninety-two underwent a fully laparoscopic (FL) procedure, and 64 procedures were performed with a robotic hybrid approach (RHA). All interventions were performed by the same surgeon, highly skilled in both laparoscopic and robotic colorectal surgery.

Inclusion criteria for surgery were: age ≥ 18 years, diagnosis of complicated sigmoid diverticulitis confirmed by abdominal CT scan with contrast. Exclusion criteria were: previous colorectal resections for diverticular disease, operations performed in emergency settings, Hartmann's procedures, malignant diseases, patient undergoing a laparoscopic exploration of the abdomen and immediate conversion to open surgery with no part of the procedure performed in laparoscopy.

A total of 54 patients were then excluded in order to avoid any confounding factor to the analysis: 43 of them who underwent a Hartmann's procedure, 2 of them who were converted to open surgery, 5 of them who received the diagnosis of malignant disease after colonoscopy, 4 of them who underwent a right colectomy for a right-sided disease.

This study was approved by the institutional Ethics Committee, and conducted according to the declaration of Helsinki. Informed consent was obtained from all patients.

Data collection

Data were prospectively recorded and retrospectively analyzed. The study database included demographic and clinical feature as age, body mass index (BMI), American Society of Anaesthesiology score (ASA) [7], previous abdominal surgery (any previous intraperitoneal procedure under general anesthesia), history of neoplastic disease, comorbidities, diverticular clinical features (complicated diverticular disease onset, recurrent episodes of diverticulitis, previous LLD or percutaneous drainage), type of surgery with or without stoma, associated procedures. Surgical details are: intraoperative time, intraoperative blood loss, conversion to open surgery and reason for conversion. Postoperative data are ICU stay, length of hospital stay, postoperative morbidity according to Clavien–Dindo classification [8], reoperation rate, 30-day mortality.

VAS scale for surgeon stress

A new visual analogue rating scale (VAS) was created to evaluate surgeon's compliance and stress during surgical minimally invasive procedures and named Cassini–Grieco–Depalma (CGD) Stress Score.

Six experienced surgeons in both laparoscopic and robotic surgery were interviewed. Every surgeon had to write a list of technical difficulties of laparoscopic and robotic abdominal surgery and grading them from 1 to 5, where 1 is a simple standard procedure and 5 a procedure that need to be converted. All the results of the interviews were matched creating a scale, divided in 5 major grades, to evaluate the technical difficulty, the surgeon compliance and the stress caused by the two different surgical approaches. Each grade has been divided in 2 subgrades to obtain a scale from 1 to 10 that could reflect the surgeon's compliance and stress during the different procedures.

The Cassini–Grieco–Depalma Stress Score is shown in Table 1.

Table 1 Cassini–Grieco–Depalma (CGD) Stress Score

1–2	Standard procedure
3–4	Light adhesions easy to separate, fatty mesentery, persistent local inflammation, brachytype
5–6	Dense bleeding adhesions, previous pelvic surgery, narrow pelvis, preoperative radiotherapy
7–8	Unclear anatomy, fibrotic adhesions, poor vision, bulking inflammatory pseudotumor, multiorgan large resection (T4), diverticular fistula
9–10	Preemptive or reactive conversion to open surgery

Outcomes

Primary goal of this study was to compare short-term outcomes of FL versus RHA groups in terms of intraoperative and postoperative results. Secondary outcome was to evaluate surgical stress based on surgeon's compliance between the two approaches.

Perioperative assessment

Elective preoperative assessment included medical history, routine physical examination, blood tests (including blood count, CRP) and CT colonography performed 2 months after the acute episode. Whenever a neoplastic lesion was suspected a colonoscopy was done, afterward.

Patients received perioperative care in the framework of the "fast-track" rehabilitation program, as detailed in authors' previous experience 9. Prophylactic antibiotic therapy with cefazoline and metronidazole was given at the beginning of the operation and continued for 24 h. Antithrombotic prophylaxis with LMWH was given at the end of the surgical operation and continued for almost 6 days, according to Caprini score [9]. After intubation, a urinary Foley catheter was placed, being removed at the end of the procedure or at last 24 h later. Blood loss during surgery was estimated by measuring the aspirated blood volume.

A perianastomotic drainage was placed in all patients, and it was removed after bowel function recovery. Clear fluids were allowed the day of the surgery, oral intake at day 1 followed by a graduated diet. Histological evaluation was performed and confirmed diagnosis of complicated diverticulitis in all cases.

Surgical technique

All patients were placed in a modified lithotomy position using adjustable stirrups with a 30° Trendelenburg and tilted to the right side. The arms were tugged alongside the patient's body to prevent shoulder injury.

After induction of pneumoperitoneum with a Veress needle (12 mmHg), a 12-mm camera port with the laparoscope (30°, 10-mm telescope) is placed 2–3 cm to the right and 3–4 cm above the umbilicus and the entire abdominal cavity was explored to evaluate feasibility of minimally invasive approach. Then other operative laparoscopic and successively robotic ports were placed, according to the standardized procedures (Fig. 1).

The dissection always started performing a laparoscopic time with medial-to-lateral mobilization using the inferior mesenteric vein as landmark. This part of dissection was performed using monopolar scissors. The peritoneum under the inferior mesenteric vein was incised, and the mesocolon was separated superiorly from Gerota's fascia, identifying the inferior edge of the pancreas and continuing laterally up to the back side of the descending colon. The inferior mesenteric vein was always sectioned between clips to facilitate further mobilization. Distally, the inferior mesenteric artery

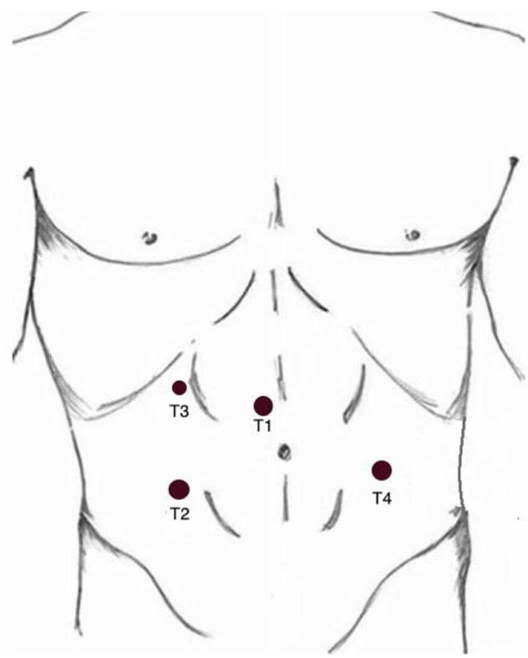

Fig. 1 Tl: 12-mm camera port (the da Vinci endoscope port 10–12 mm) is placed 2–3 cm to the right and 3–4 cm above the umbilicus. T2: (12-mm trocar/8 mm robotic) is placed at least 10 cm from Tl camera port on the right spinoumbilical line where it crosses the midclavicular line. T3: (5-mm trocar) is placed 10 cm above T2 on the right midclavicular line. T4: 12-mm trocar/8 mm robotic) is placed at least 10 cm from Tl camera port on the left spinoumbilical line where it crosses the midclavicular line

was identified at its origin and, if possible, only left colic artery was sectioned between clips.

The division of the gastrocolic, splenocolic and the remaining ligaments of the descending colon allowed a correct mobilization of the splenic flexure without any tension.

At this moment, only in the Robotic group, the three arms of da Vinci® S Surgical System (Intuitive Surgical, Inc., Sunnyvale, CA) were docked, placing the robotic cart along the left hip of the patient, with an angle of approximately 45° between the camera and the transverse umbilical line. The sigmoid mesentery was elevated superiorly by a Cadière forceps/assistant forceps, and following the inferior mesentery artery, the holy plane between the fascia propria of the rectum and the parietal fascia was identified. The hypogastric nerves, the left ureter and gonadic vessels were identified, accurately dissected and preserved.

The dissection was carried out along the pelvic sidewall up to the superior part of the intraperitoneal rectum. At this moment, the section of the rectum was made with a linear flexible stapler introduced into the assistant port.

After the de-docking process, a Kustner's suprapubic incision of 4/5 cm was done in order to exteriorize the descending colon and perform a purse-suture for the anvil. Then, the colon with the anvil was replaced in the pelvic cavity and the abdominal incision was closed. An end-to-end anastomosis was created in all patients by using a rectally introduced circular stapler of 29 mm.

Statistical analysis

Quantitative data were reported as mean ± standard deviation (range). Normally distributed quantitative data were analyzed with the Student *t* test. Mann–Whitney test was used otherwise. Qualitative data were reported as number of patients (percentage of patients) and were compared with the Pearson χ^2 test.

All tests were 2-sided with a significance level set at 5%. Statistical significance was defined as p value < 0.05.

All analyses were performed using the IBM SPSS version 23 (IBM Co., Armonk, NY, USA).

Results

Demographic and clinical details

The FL and RHA groups were well matched for age (mean value of 67.42 ± 13.1 years in the FL group and 68.68 ± 11.8 years in the RHA group, p 0.366) and BMI (mean value of 27.63 ± 3.34 in the FL group and 27.55 ± 4.25 in the RHA group, p 0.898), but not for sex with a female/male ratio of 2.12 (F:M = 106:50). As shown in Table 2, differences according to ASA classifications were not statistically significant (p 0.264) and the distribution of the population was as follows: ASA I, 7.7% in the FL group and 6.3% in the RHA group; ASA II, 68.4% in the FL group and 60.9% in the RHA group ; ASA III, 23.9% in the FL group and 32.8% in the RHA group ; no patient was classified as ASA IV in either group. In the FL group, 33.6% of subjects had a previous abdominal surgery, compared to 48.4% in the RHA group. Clinical presentation of diverticular disease in the FL group showed: 45.6% of patients treated for an acute form of complicated diverticulitis; 36.9% of them presenting a chronic complicated diverticular disease including stenosis (28 cases), recurrent bleeding (3 cases) and colonic fistula (3 cases).

In the RHA group, clinical presentation was as follows: 31.2% of patients treated for an acute form of complicated diverticulitis; 48.4% presenting a chronic complicated diverticular disease including stenosis (25 cases), recurrent bleeding (2 cases), colonic fistula (3 cases) and inflammatory bulky pseudotumor (1 case).

The remaining cases were referred to surgery after several episodes of mild diverticulitis, after evaluation of their quality of life (17.4% in the FL group versus 20.3% in the RHA group). For 6 patients in the FL group and 3 in the RHA group, an elective colorectal resection was performed after radiological placement of a percutaneous drainage or a laparoscopic lavage and drainage procedure, with a mean time between the procedure and surgery of 3.8 months in the FL group and 4 months in the RHA group (p 0.467).

Surgical procedure

As demonstrated in Table 3, all patients underwent an elective surgery, consisting in a recto-sigmoid resection in 92.3% of cases in the FL group versus 95.3% of cases in the RHA group (p 0.484). Associated procedures depending on clinical presentation were in most of cases a wide, cautious adhesiolysis (FL: 14.1% vs. RHA: 25%, p < 0.05), ureteral J stenting or bladder wall resection in case of colovesical fistula (FL: 2.17% vs. RHA: 1.6%, p 0.136), ileal segmental resection (FL: 1.1% vs. R: 1.6%, p 0.136) and ovariectomy or vaginal wall resection in case of colovaginal fistula (FL: 5.4% vs. RHA: 3.1%, p 0.249).

Loop ileostomy was performed in 4 cases after the laparoscopic procedure and in 2 cases after the hybrid approach. A loop colostomy was done in 1 case after resection of a bulky, inflammatory pseudotumor in the RHA group.

Short-term outcomes

As outlined in Table 4, mean operative blood loss was 144.6 ± 40.6 ml (40–200) in the FL group and 138.4 ± 28.3 ml (20–185) in the RHA group (p 0.295). No

Table 2 Demographic and clinical features ($n = 156$)

	FL ($n = 92$)	RHA ($n = 64$)	p
Sex (n, %)			
Male	33 (35.9)	17 (26.5)	0.248
Female	59 (64.1)	47 (73.5)	0.223
Age, year (mean ± SD, range)	67.42 ± 13.1 (31–87)	68.68 ± 11.8 (31-86)	0.366
BMI, kg/m^2 (mean ± SD, range)	27.63 ± 3.34 (20.95–42.23)	27.55 ± 4.25 (20.7–47.32)	0.898
ASA classification (n, %)			0.264
I	7 (7.7)	4 (6.3)	
II	63 (68.4)	39 (60.9)	
III	22 (23.9)	21 (32.8)	
Previous abdominal surgery (n, %)	31 (33.6)	31 (48.4)	0.058
History of neoplastic disease (n, %)	6 (6.5)	5 (7.8)	0.051
Comorbidities (n, %)			0.765
Diabetes	7 (7.6)	6 (9.3)	
Hypertension	17 (18.4)	19 (29.6)	
Cardiovascular disease	10 (10.8)	10 (15.6)	
Thyroid disease	(3.2)	2 (3.1)	
Respiratory disease	(4.3)	(7.8)	
Diverticular disease (n, %)			
Acute complicated diverticulitis	42 (45.6)	20 (31.2)	
Chronic complicated diverticulitis with stenosis	28 (30.4)	25 (39.0)	
Chronic complicated diverticulitis with bleeding	3 (3.2)	2 (3.2)	
Chronic complicated diverticulitis with fistula	3 (3.2)	3 (4.6)	
Chronic inflammatory pseudotumor	–	1 (1.5)	
Recurrent diverticular disease	16 (17.4)	13 (20.3)	
Several episodes of diverticulitis (n, %)	18 (19.5)	15 (23.4)	0.079
Previous LLD/percutaneous drainage	5 (5.4)/1 (1.1)	3 (4.6)/–	0.236
Time to surgery months (mean ± SD, range)	3.8 ± 0.5 (1–5)	4 ± 1.2 (1–8)	0.467

Table 3 Surgical procedures ($n = 156$)

	FL ($n = 92$)	RHA ($n = 64$)	p
Type of surgery (n, %)			
Recto-sigmoid resection	85 (92.3)	61 (95.3)	0.484
Left colectomy	7 (7.6)	3 (4.6)	0.227
Associated surgery (n, %)	31 (33.6)	31 (48.4)	
Adhesiolysis	13 (14.1)	16 (25)	< 0.05
Ureteral J stenting/vesical resection	2 (2.17)	1 (1.6)	0.136
Ileal resection	1 (1.1)	1 (1.6)	0.136
Ovariectomy/vaginal resection	5 (5.4)	2 (3.1)	0.249
Other	1 (1.1)	1 (1.6)	0.136
Ileostomy (n, %)	4 (4.3)	2 (3.1)	0.085
Colostomy (n, %)	–	1 (1.6)	< 0.05

conversion was experimented in the RHA group, while 6.5% of patients in the FL group had a conversion to open surgery ($p < 0.05$) for dense adhesions (3 patients), bulky pseudotumor (2 patients) and poor vision due to abdominal distention (1 patient). Mean operative time was 167.5 ± 54.4 min (range 80–420) in fully laparoscopic approach and 172.5 ± 55.64 min (range 110–325) in the robotic-assisted procedure (p 0.797).

Both groups had a similar length of hospital stay with a mean for FL of 5 ± 4.1 days (range 3–45) and 5 ± 2.7 days (range 3–20) for RHA (p 0.190). Perioperative blood transfusion was required in 2 patients in the FL group only. Differences were also seen as for ICU stay, with 13% of patients in the FL group needing ICU care (mean ICU stay: 2.91 ± 3.34 days, range 1–13) versus 1.6% of patients in the RHA groups (mean ICU stay: 5 days) with a p value < 0.05.

The overall postoperative minor morbidity (Clavien–Dindo 1 and 2) reached 16.3% globally, showing no statistical difference between the two groups (8.6% in the FL group and 7.7% in the RHA group, p 0.850). The incidence of the overall postoperative major morbidity (Clavien–Dindo 3 and 4) accounted 17.6% globally, represented by 13% in the FL group versus 4.6% in the RHA group (p 0.041). Among them, 8 subjects in the FL group and 2 subjects in the RHA group needed a surgical reintervention (p 0.146),

Table 4 Outcomes ($n = 156$)

	FL ($n=92$)	RHA ($n=64$)	p
Mean operative time, min (mean ± SD, range)	167.5 ± 54.4 (80–420)	172.5 ± 55.64 (110–325)	0.797
Mean intraoperative blood loss, ml (mean ± SD, range)	144.6 ± 40.6 (40–200)	138.4 ± 28.3 (20–185)	0.295
Conversion to open surgery (n, %)	6 (6.5)	–	< 0.05
Reason for conversion (n, %)			< 0.05
Adhesions	3 (50)	–	
Inflammatory pseudotumor	2 (33.3)	–	
Abdominal distension	1 (16.6)	–	
ICU stay (n, %)	12 (13)	1 (1.6)	< 0.05
Mean stay, days (± SD, range)	2.91 ± 3.34 (1–13)	5[a]	< 0.05
Mean hospital stay, days (mean ± SD, range)	5 ± 4.1 (3–45)	5 ± 2.7 (3-20)	0.190
30-day mortality (n, %)	–	–	–
Overall postoperative morbidity (n, %)	20 (21.6)	8 (12.3)	0.067
Postoperative morbidity Clavien–Dindo I (n, %)	5 (5.4)	4 (6.2)	0.05
Postoperative morbidity Clavien–Dindo II (n, %)	3 (3.2)	1 (1.6)	0.079
Postoperative morbidity Clavien–Dindo III (n, %)	6 (6.5)	2 (3.1)	
Incisional hernia	2	–	0.071
Ileal microperforation	2	–	0.071
Superficial hematoma	1	–	< 0.05
Anastomotic stenosis	–	1	< 0.05
Occlusion	–	1	< 0.05
Medical	1	–	< 0.05
Postoperative morbidity Clavien–Dindo IV (n, %)	6 (6.5)	1 (1.5)	
Anastomotic dehiscence	2	–	0.071
Jejunal perforation	–	1	< 0.05
Peritonitis	1	–	< 0.05
Bleeding	1	–	< 0.05
Medical	2	–	0.071
Reoperations (n, %)	8 (8.6)	2 (3.1)	0.146
Percutaneous drainage (n, %)	1 (1.1)	1 (1.5)	0.136
Postoperative blood transfusion (n, %)	2 (2.1)	–	0.071

[a]Just 1 patient in ICU

while 1 individual in both groups was treated by means of a percutaneous drainage placed not under general anesthesia (p 0.136).

Analyzing surgeon's compliance (Fig. 2), robotic-assisted procedure showed a better significant result with a mean value of 2.59, compared to a mean value of 3.61 in the fully laparoscopic approach (p 0.042).

Discussion

According to the recent Italian consensus on diverticulitis [1], the authors included in the study all patients requiring surgical elective colorectal resections for diverticular disease, after balancing the quality of life, the severity of symptoms, the risk of recurrence and the morbidity of surgery. It is widely accepted, as stated by Klarembeek et al.

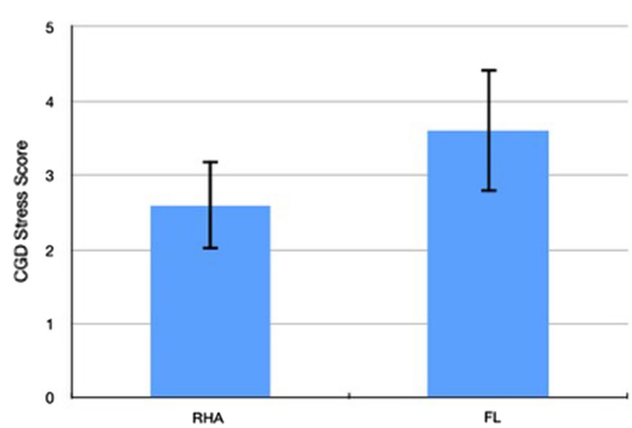

Fig. 2 RHA procedures showed a mean CGD Stress Score of 2.59, FL procedures showed a mean CGD Stress Score of 3.61 (p 0.042)

[10, 11], that laparoscopic approach for elective resections shows better short-term outcomes when compared to open surgery, with a total reduction of 27% in major morbidity, minor length of hospital stay, minor postoperative pain and better postoperative quality of life score.

Nonetheless, complicated diverticular disease is still a challenging surgical field associated with major intraoperative and postoperative surgical complications, such as vascular and ureteral injury, anastomotic leak or dehiscence, intra-abdominal abscess, bleeding and wound infection [12–15]. This is particularly true when peri-colonic abscesses and fistulas, pelvic inflammatory pseudotumors and adhesions are present, thus modifying all anatomical planes with tissues usually harder and prone to bleeding.

In a previous experience in the field of deep pelvic endometriosis [16], authors proved that robotic surgery shows all its potential in narrow fields in order to obtain a precise and safe dissection with decreased blood loss, a rigorous ureter preparation and pelvic nerve preservation. These data are also confirmed by Kim et al. [17] when evaluating the impact of the robotic approach for rectal cancer resection.

In this series of patients, authors proved a better, but not statistically significant intraoperative performance of hybrid procedure in terms of blood loss (144.6 ml in the FL group vs. 138.4 ml in the RHA group, p 0.295) at the cost of a not statistically significant longer intraoperative time (167.5 min in the FL group versus 172.5 min in the RHA group; p 0.797). No patient in the RHA group compared to 6.5% of patients in the FL group ($p < 0.05$) had a conversion to open surgery for dense adhesions (3 patients), inflammatory, bulky pseudotumor (2 patients) and poor vision due to abdominal distention (1 patient). However, this result could also be explained if considering that all these cases were converted during the laparoscopic time, before performing any robotic docking, and it could be an intrinsic bias of the study. A fully robotic procedure with the da Vinci Xi® System could clarify this outcome.

No differences were seen in terms of length of hospital stay (mean value of 5 ± 4.1 days for the FL group and 5 ± 2.7 days for the RHA group, p 0.190), nor postoperative 30-day mortality (none in both groups) and minor postoperative morbidity (Clavien–Dindo 1–2 of 8.6% in the FL group and 7.7% in the RHA group, p 0.850). Instead, differences were reported when comparing major postoperative morbidity (Clavien–Dindo 3–4), with a prevalence of surgical and medical morbidity in the FL group (13%) compared to the RHA group (4.6%), with a p value of 0.041. Most interestingly, 8.6% of patients in the FL group versus 3.1% in the RHA group needed a second surgery for a postoperative complication. These results are in line with the systematic review conducted by Haas [15] who reported an overall postoperative complication rate of 32.64% depending on surgical timing and approach (53.6% following emergent surgery versus 22.52% following elective surgery; 22.48% following a laparoscopic approach versus 41.26% following an open approach).

To analyze surgeon's fatigue and compliance during the two minimally invasive approaches the Cassini–Grieco–Depalma Stress Score was used, ranging from one to ten the surgeon's compliance and stress, with 1 being the standard operation and 10 being an unavoidable conversion to laparotomy. As clearly demonstrated in a recent review [18], a hybrid technique (robotic-assisted laparoscopy) is less strenuous when compared to traditional laparoscopy. As much as 74% of laparoscopic surgeons do have physical complaints during their procedures. Despite patients' advantages of robotic surgery have been largely demonstrated [19–21], few studies have examined how robotic technology benefits surgeons [22]. While the poor precision and ergonomics of laparoscopy may exacerbate stress, the improved 3D vision and the endoWrist technology associated with robotic approach might help surgeons cope better with fatigue [23]. Furthermore, as proved by Moore [24], surgeons' cardiovascular responses are more favorable during stressful tasks when using a robotic system, rather than laparoscopic tools. Equally, the learning curve for novices as well as the intracorporeal suturing performance improves, while decreasing their workload [25]. In this context, this study confirms the benefits of robotic surgery, by analyzing the direct experience of the operator practicing both approaches. In this study, robotic-assisted procedure showed a better surgeon's compliance with a mean Cassini–Grieco–Depalma Stress Score of 2.59, compared to a mean value of 3.61 in the fully laparoscopic approach (p 0.042).

The main biases of the present study are represented by the limited number of patients examined in a single center and performed by the same surgeon. Further prospective, multicenter analyses need to be performed in order to clarify the potential benefits of robotic technology in the current practice for colorectal resections in diverticular disease.

Conclusions

This preliminary study highlights the potential benefits of robotic-assisted laparoscopy in colorectal resections for complicated diverticular disease in terms of surgical efficacy and anatomical dissection, postoperative morbidity and better surgeon's compliance.

Compliance with ethical standards

Disclosures Diletta Cassini, Norma Depalma, Michele Grieco, Roberto Cirocchi, Farshad Manoochehri and Gianandrea Baldazzi have no conflicts of interest or financial ties to disclose.

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