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ORIGINAL ARTICLE

Colorectal surgery in elderly patients: our experience with DaVinci Xi® System

A. Oldani[1] · P. Bellora[1] · M. Monni[1] · B. Amato[2] · S. Gentilli[1]

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Abstract
Background Robotic technology for colorectal surgery was introduced by Weber in 2002 to improve the benefits of the minimally invasive surgery already offered by the laparoscopic approach.
Aims To evaluate the feasibility and the efficacy of the application of robotic surgery in elderly patients affected by colorectal diseases.
Methods We reported the outcomes obtained during our first 50 colorectal robotic surgical performances with DaVinci Xi® System, and we compared the results assessed for patients younger or older than 70 years.
Results We examined 28 patients younger and 22 older than 70 years who underwent colorectal robotic surgery in our institution from September 2014 to June 2016. We performed 15 right colectomies, 20 left colectomies, 15 rectal resections. Mean ASA score was significantly higher in the Elderly Group. No statistically significant differences have been revealed in terms of post-operative morbidity, hospital stay, first diet intake, first flatus canalization and oncological outcome.
Discussion According to the prolonged operative time, robotic technology was initially reserved to young patients with good performance status in order to avoid systemic failures in elderly patients suffering from pre-existent comorbidities. Otherwise, once robotic approach safety and benefits in terms of better systemic outcomes were demonstrated, it started to be performed in elderly patients with satisfactory outcomes.
Conclusion Our experience revealed that robotic surgical approach is safe, feasible and offers many systemic benefits in elderly patients also with high ASA score. Age alone has not to be considered as exclusion criteria for robotic approach.

Keywords Robotic surgery · Colectomy · Rectal resection · Colorectal cancer

Abbreviations

CRS	Colorectal surgery
BMI	Body mass index
ASA	American Society of Anaesthesiologists
YG	Younger Group
EG	Elderly Group
RC	Right colectomy
CME	Complete mesocolic excision
LC	Left colectomy
RR	Rectal resection
LNs	Lymph nodes
AJCC	American Joint Committee on Cancer
NCCN	National Comprehensive Cancer Network
SUL	Spino—umbilical line
MCL	Middle—clavicular line
TUL	Transverse umbilical line

Introduction

Robotic technology for colorectal surgery (CRS) was introduced for the first time in 2002 by Weber at al. [1] to improve the feasibility of minimally invasive surgical approach, started by laparoscopy at least 20 years ago.

✉ A. Oldani
alberto.oldani@libero.it

[1] Department of Surgery, University of Eastern Piedmont - AOU "Maggiore della Carità" Hospital, Corso Mazzini 11, 28100 Novara, Italy

[2] Department of Clinical Medicine and Surgery, University "Federico II", Naples, Italy

At the beginning, robotic CRS feasibility and oncological adequacy compared to open and laparoscopic approach were mistrust, but it has been demonstrated the reliability and the concrete advantages offered in terms of faster recovery time, lower post-operative pain, low complications rate and oncological adequacy [2]. Indeed, some doubts about its application are still related to the higher costs that robotic instruments require compared to the laparoscopic tools and to the longer operative time [3].

As all new techniques, robotic CRS started to be performed in selected patients, young people with low BMI and ASA scores and good performance status: at the beginning, patients older than 70 years were ruled out from the robotic CRS, according to an hypothetical higher risk of post-operative systemic complications due to the longer operative time, to the maintenance of Trendelemburg position and the prolonged pneumoperitoneum [4].

Furthermore, when robotic CRS has revealed feasible and safe with improved systemic outcomes for young patients, many authors started to approach robotically elderly (age $>$ 70 years) patients too, and their results assessed the feasible extension of the benefits of this improved minimally invasive approach also to elderly people [5].

Patients and methods

We started to approach CRS robotically with the DaVinci Xi® System (Intuitive Surgical Inc., Sunnyvale, CA) since September 2014.

From September 2014 to June 2016, we performed CRS robotically for both malignancies and benign diseases. In this report, we have enrolled 50 patients (25 males 50% vs. 25 females 50%), who have been divided in two different groups according to the age criteria younger or older than 70 years: the Younger Group (YG) 28 patients (median age 57.4 years; range 44–68 years) and the Elderly Group (EG) 22 patients (median age 76.9 years; range 70–92 years).

A subsequent division is assessed on the different disease sites: right colectomy (RC 15—YG 6 vs. EG 9), left colectomy (LC 20—YG 15 vs. EG 5) and rectal resections (RR 15—YG 7 vs. EG 8). For both groups, all the surgical procedures for right colon and rectum were performed for malignancies, while 9 YG patients underwent left colectomy for benign disease as sigmoid diverticular stricture.

The study reports the clinical and oncologic outcomes of colorectal robotic surgery with a comparison between two groups of patients older than 70 years and younger subjects with significant lower surgical risk factors.

Results

Right colectomy (RC)

We performed 15 right colectomies (RC) for right-sided colonic cancers: 2 located at the caecum, 11 ascending colonic malignancies, 1 at transverse colon and 1 high dysplasia adenoma not resectable during colonoscopy.

Six patients were included in the YG group, while 9 older than 70 years were enrolled in the EG.

We performed a standardized full robotic medial-to-lateral RC with complete mesocolic excision (CME) according to Hohemberger's technique [6] with vessels ligation (CVL) at the origin from superior mesenteric artery (SMA) and superior mesenteric vein (SMV), extended lymphadenectomy and finally have fashioned intracorporeal mechanic side-to side ileo-colic anastomosis with 60-mm linear stapler.

The ports set-up for all the procedures on the right abdomen is shown in Fig. 1: we placed all the ports on a straight vertical line parallel and 4 cm on the left of the middle line as follows: the first endoscope port (P2) is placed on this line 3 cm below the transversal umbilical line. Port 1 (P1) is placed along the vertical line distant 6–8 cm below P2. Ports 3 (P3) and 4 (P4) are placed above Port 2, 8 cm away from each other.

"Airseal" is triangulated on P1 and P3, usually on transversal umbilical line and distant at least 2 cm of superior iliac spine: the distances reported are suggested for median-sized patients. Indeed, the distance of each port from the others has been tailored according to the patient body size: to avoid intracorporeal instruments conflicts, we suggest that obese or high BMI patients require a ports placement nearer the median line, while thinner patients can benefit from a port disposal farther from the median line.

We define as transversal umbilical line the one across the real navel, defined as the median point of a line running from the xyphoid to the pubic bone, that often is noncorrespondent to the navel site.

The demographics about our patients (Table 1) report a median age for Younger Group (YG) of 61.6 years (range 55–68 years) and median age for Elderly Group (EG) of 73.8 years (median range 71–83 years), with a prevalence of female gender in YG (5 females vs. 1 male) and male gender in EG (6 M vs. 3 F).

Concerning the ASA score and the BMI, higher values are known as risk factors related to post-operative complications; all YG patients were classified as ASA 2 with a median BMI of 28.2 (range 23.9–30.5), while the EG revealed an higher number of ASA 3- and ASA 4-scored patients, according to the presence of co-existent

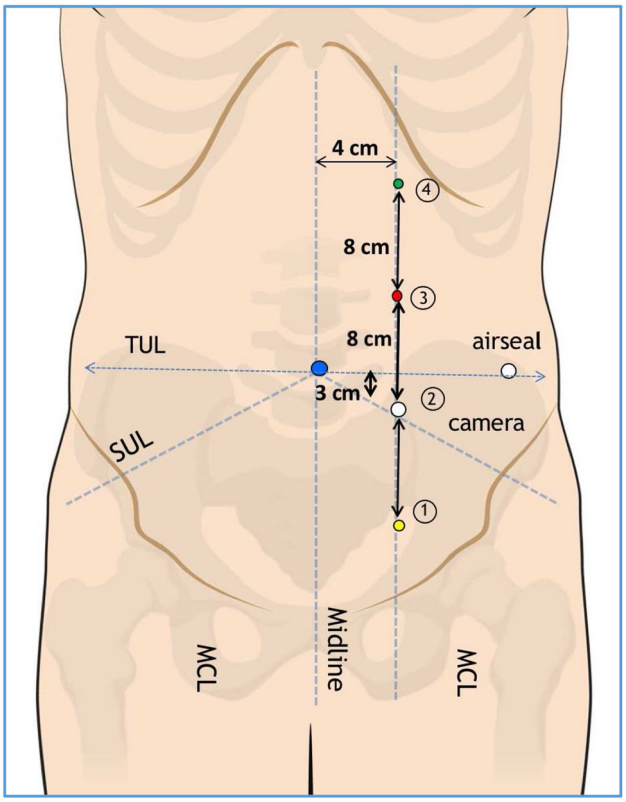

Fig. 1 Ports placement for full robotic RC—CME

Table 1 Demographics of patients that underwent full robotic RC—CME

	Young 6	Elderly 9
Age (years)	61.6 years (55–68 years)	73.8 years (71–83 years)
BMI (kg/m)	28.2 (23.9–30.5)	25.6 (22.2–31.6)
Sex	M 1 F 5	M 6 F 3
ASA score	**1**:0 (0 F vs. 0 M)	**1**:0 (0 F vs. 0 M)
	2:6 (5 F vs. 1 M)	**2**:4 (2 F vs. 2 M)
	3:0 (0 F vs. 0 M)	**3**:4 (1 F vs. 3 M)
	4:0 (0 F vs. 0 M)	**4:**1 (0 F vs. 1 M)

comorbidities such as past heart failures, diabetes, systemic hypertension, anaemia, chronic pulmonary diseases.

The median BMI for EG was 25.6 (range 22.2–31.6).

The respect of the oncologic adequacy and the standardization of surgical procedures for both groups, according to the NCCN guidelines criteria [7], are confirmed by the description of the surgical specimens by the pathologist (Table 2): no statistically significant difference has been reported in terms of median length of the colonic specimen, YG 32.5 cm (range 17–52 cm) versus EG 34.5 cm (range 19–60 cm), neoplastic distance from proximal margin YG 11.1 cm (range 3–35 cm) versus EG 10.6 cm (range 5–16 cm) and from distal margin too YG 20.5 cm (range 4–40 cm) versus EG 17.8 cm (range 8–40 cm). No patient suffered from neoplastic involvement of the transection sites.

The cancer median size was similar for both groups YG 4.7 cm (range 1–7.5 cm) versus EG 4.3 cm (range 0.8–9 cm). Furthermore, at least 12 lymph nodes were harvested for each patient for both groups: the median number of lymph nodes achieved is YG 24.2 (range 12–45) versus EG 18.3 (range 12–34).

The post-operative cancer staging, according to AJCC classification, for YG reports Stage I 1 pt, Stage III 3 pts, no patients staged as Stages II and IV. Two patients, who were diagnosed with severe dysplasia flat adenomas not radically resectable by endoscopy, had no evidence of disease (NED) in the surgical specimen. The AJCC staging for EG reports Stage I 2 pts, no patients staged as Stage II, Stage III 4 pts and Stage IV 2 pts: as reported before about YG, a patient of EG has finally revealed as NED.

The comparison of post-operative outcomes, according to the limited number of patients enrolled, reports no 30-day post-operative mortality, no post-operative complications; only one patient of the YG was converted to open approach by the onset of a massive bleeding from the median colic vessels.

No blood transfusion was necessary before or after surgery for YG, while two EG were blood transfused before surgery due to severe anaemia at pre-operative blood tests.

The systemic outcomes evaluation showed no statistically significant difference between the two groups: the median time of first flatus was 2.16 days for YG (range 1–5 days) versus 2.4 days for EG (range 1–5 days), while the soft diet intake restarted after the same time (3.5 days) even for YG and EG (range 3–6 days); the median discharge time was for YG about 5.66 days (range days) versus 5.22 days for EG (range days).

Left colectomy (LC)

We performed a total of 20 colectomies (including 3 resections of the splenic flexure for cancer): as described before, we divided the patients in two different groups according the age criteria: all the EG underwent robotic LC for malignancies, while in the YG (15 pts), 9 patients suffered from left colonic sigmoid diverticular disease and 6 patients were diagnosed of malignancies.

All patients underwent the same medial-to-lateral full robotic LC technique in which the patient is slightly turned on the right in Trendelemburg position. We place the first endoscope port (P2) 4 cm above and 4 cm on the right of the umbilicus (main point); then, we find a point for P1 on

Table 2 Oncologic and clinical outcomes after full robotic RC—CME

Outcomes	Young	Elderly
Conversion rate (%)	1 pts F	0 pts
Oral soft diet (days)	3.5 days (2–6 days)	3.5 days (2–6 days)
First flatus (days)	2.16 days (1–5 days)	2.4 days (1–5 days)
Discharge (days)	5.66 days (4–11 days)	5.22 (4–11 days)
LNs harvested (n)	24.2 (12–45)	18.3 (12–34)
Specimen length (cm)	32.5 cm (17–52 cm)	34.5 (19–60 cm)
Cancer size (cm)	4.7 cm (1–7.5 cm)	4.3 cm (0.8–9 cm)
Proximal margin (cm)	11.1 cm (3–35 cm)	10.6 cm (5–16 cm)
Distal margin (cm)	20.5 cm (4–40 cm)	17.8 cm (8–40 cm)
AJCC stage (n)	**I**:1 (1 F vs. 0 M)	**I**:2 (1 F vs. 1 M)
	II:0 (0 F vs. 0 M)	**II**:0 (0 F vs. 0 M)
	III:3 (2 F vs. 1 M)	**III**:4 (1 F vs. 3 M)
	IV:0 (0 F vs. 0 M)	**IV**:2 (1 F vs. 1 M)
	NED:2 (2 F vs. 0 M)	**NED**:1 (0 F vs. 1 M)
Mortality at 30 days (%)	0% (0 pts)	0% (0 pts)
Blood transfusion	0 pts	2 pts
Post-op. complications rate (%)	0% (0 pts)	0% (0 pts)

middle line distant at least 8 cm from P2. On the line drawn between these two points, we place P3 and P4 at the distant of 8 cm from each other. Assistant port is triangulated on P3 and P4, on the right. (Fig. 2) With DaVinci Xi, it is possible to switch the camera from P2 and P3 during the various phases of the procedure (endoscope in P3 for vessel ligation and pelvic dissection, endoscope in P2 for splenic flexure mobilization). Moreover, with this particular robotic platform there is no need to place any ports in left iliac fossa (Fig. 2).

All the LC managed for malignancies underwent vessel transection at their origin, extended lymphadenectomy and intraoperative evaluation of perfusion stumps adequacy.

The pre-operative staging for cancer includes CT thorax–abdomen scan, complete colonoscopy with biopsy and anesthesiological evaluation.

For patients suffering from benign diseases, left colonic vessels were spared when possible, so we preferred more peripheral vessel ligature.

The anastomotic was performed with different techniques according to the site, the dimensional gap between the stumps and the most favourable perfusion detected: side-to-side either side-to-end transanal anastomosis with circular stapler 29, while after the splenic flexure resection we performed side-to-side intracorporeal colonic anastomosis through linear stapler 60 mm.

The patients demographics as reported in Table 3 define a median age for Younger Group (YG) of 55.5 years (range 44–67 years) and median age for Elderly Group (EG) of 76 years (median range 74–78 years), with an higher number of male patients in YG (6 females vs. 9 male) and females in EG (1 males vs. 4 females).

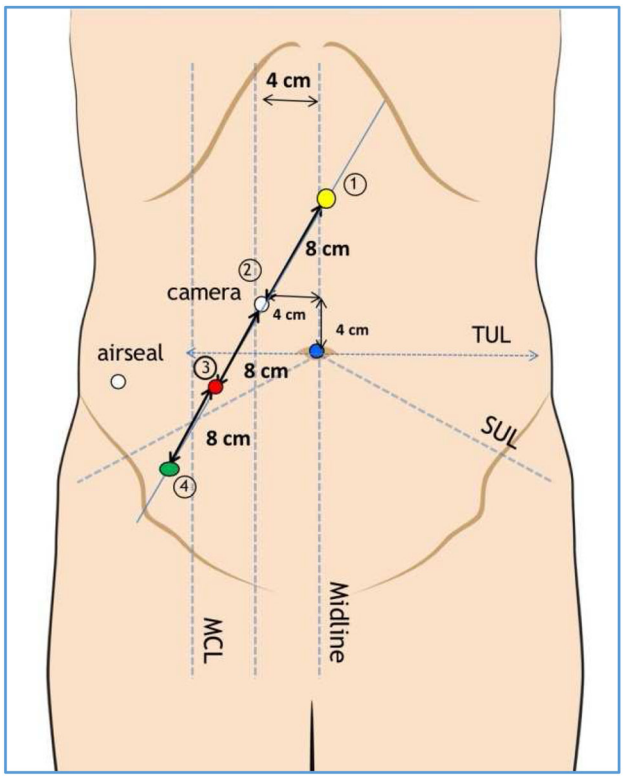

Fig. 2 Ports placement for full robotic LC

The pre-operative risk evaluation was performed through the assessment of the ASA and the BMI scores: in the YG, there was a prevalence of ASA 2 score (12 pts), followed by 1 patient for both ASA 1 and ASA 3 score: no patients were assessed as ASA 4 score. Indeed, in the EG group, no ASA 1 was determined, while both ASA 2 and

Table 3 Demographics of patients that underwent full robotic LC

	Young 15	Elderly 5
Age (years)	55.5 years (44–67 years)	76.0 years (74–78 years)
BMI (kg/m)	24.5 (22.2–27.9)	30.0 (26.0–39.0)
Sex	M 9 F 6	M 1 F 4
ASA score	1:2 (1 F vs. 1 M)	**1**:0 (0 F vs. 0 M)
	2:12 (5 F vs. 7 M)	**2:**2 (2 F vs. 0 M)
	3:1 (0 F vs. 1 M)	**3**:2 (1 F vs. 1 M)
	4:0 (0 F vs. 0 M)	**4**:1 (1 F vs. 0 M)

ASA 3 involved 2 patients, and 1 patient was classified as ASA 4.

The median BMI in the YG was about 24.5 (range 22.2–27.9), lower if compared to median BMI of the EG that was 30 (range 26–39).

All the LC in EG group (5) were performed for malignancies, while in the YG (15), 9 patients underwent LH for benign disease, as sigmoid diverticular stricture; the remaining 6 patients suffered from left colonic sigmoid cancers.

The robotic LC procedures for cancer were all conformed to the NCCN guidelines for oncological adequacy, as confirmed by histological examination and reported in Table 4: no statistically significant difference has been reported in terms of median length of the colonic specimen, YG 21.5 cm (range 16–35 cm) versus EG 20.5 cm (range 17–25 cm); neoplastic distance from both proximal margin YG 9.3 cm (range 6.5–12 cm) versus EG 6.8 cm (range 3–10.5 cm); and distal margin YG 11.4 cm (range 6–14 cm) versus EG 10.1 cm (range 3–10.5 cm).

All the procedures had revealed as R0, with no residual neoplastic tissue, and no stomas were fashioned in any group.

The cancer median size was similar for both groups YG 3.12 cm (range 0.6–5 cm) versus EG 3.46 cm (range 1–6.5 cm); at least 12 lymph nodes were achieved for each patient for both groups: the median number of lymph nodes harvested for YG is 13.2 (range 12–17) versus EG 14 (range 12–16).

The post-operative AJCC cancer staging reports for YG 1 pt at Stage I, 2 pts at Stage II, Stage III 1 pt, no patients staged as Stages II and IV. Two patients, who underwent LH by the onset of severe dysplasia colonic adenomas not endoscopically resectable, were finally staged as NED. According to the AJCC post-operative staging, for EG the results are: Stage I 1 pt, no patients staged as Stages II and Stage IV, 2 pts Stage III while 2 patients had no presence of residual malignance, so they were defined as NED.

Our results about post-operative outcomes (Table 4) report no post-operative death at 30 days from surgical procedure and no intraoperative conversion to open or laparoscopic approach. Just 1 male patient of the YG, who underwent LH for sigmoid diverticular stricture in a pattern of diffuse and extended diverticular colonic disease, required reintervention due to the perforation of diverticulum left in the residual colon spared from surgery.

No blood transfusions were managed before or after surgery for EG patients, while two YG male patients have been blood transfused by the onset of severe post-operative anaemia.

The systemic outcomes evaluation did not reveal statistically significant differences between the two groups: the median time of first flatus was 2.20 days for YG (range 1–5 days) versus 2.6 days for EG (range 3–5 days); the soft diet intake required 3.66 days for the YG (range 2–8 days) versus 4.75 days for the YG (range 3–8 days); the median discharge time was for both groups faster than a week, for YG about 6.4 days (range 4–19 days) versus 6.75 days for EG (range 4–11 days).

Rectal resections (RR)

Fifteen rectal resections (including 1 Miles' abdominoperineal resection for anal canal cancer) with full robotic technique were performed: as for the others cancer sites, our patients were divided in an YG (7:3 rectal anterior resections, 4 ultra-low rectal resections) and in an EG (8: 1 Miles' abdominoperineal resection; 5 rectal anterior resections; 2 Hartmann's rectal resections).

The ports placement for RR is quite similar as described before for LH (Fig. 3): the standardized approach was the medial-to-lateral, and all RR were managed with splenic flexure take down to allow the complete residual colonic mobilization to fashion the pelvic anastomosis. According to Heald's described principles [7], all RR were managed with the nerve sparing TME technique. Before surgery, all patients were aware about the chance of stoma fashioning, so the stoma site was drawn on patient skin the day before surgery.

Patient is set on the right in Trendelemburg position, and the first port is placed (P2) 4 cm above and 4 cm on a landmark at the right of the navel: P1 is located on middle line distant at least 8 cm from P2, and finally, on the line running between these two points we place P3 and P4 at the distance of 8 cm from each other. Assistant port is triangulated on P3 and P4, on the right side (Fig. 3).

Differently from the DaVinci Si® System, which is provided of a robotic arm dedicated for the camera alone, every DaVinci Xi® System arm is able to support any instrument available, including the camera: this consents to the surgical equipment to change the

Table 4 Oncologic and clinical outcomes after full robotic LC

Outcomes	Young	Elderly
Conversion rate (%)	0 pts	0 pts
Oral soft diet (days)	3.66 days (2–8 days)	4.75 days (3–8 days)
First flatus (days)	2.20 days (1–5 days)	3.5 days (2–6 days)
Discharge (days)	6.4 days (4–19 days)	6.75 (4–11 days)
LNs harvested (n)	13.2 (12–17)	14.0 (12–16)
Specimen length (cm)	21.5 cm (16–35 cm)	20.5 (17–25 cm)
Stoma fashioning		0 pts
Cancer size (cm)	3.12 cm (0.6–5 cm)	3.46 cm (1–6.5 cm)
Proximal margin (cm)	9.3 cm (6.5–12 cm)	6.8 cm (3–10.5 cm)
Distal margin (cm)	11.4 cm (6–14 cm)	10.1 cm (3–10.5 cm)
AJCC stage (n)	**I**:1 (1 F vs. 0 M)	**I**:1 (0 F vs. 1 M)
	II:2 (1 F vs. 1 M)	**II**:0 (0 F vs. 0 M)
	III:1 (0 F vs. 1 M)	**III**:2 (2 F vs. 0 M)
	IV:0 (0 F vs. 0 M)	**IV**:0 (0 F vs. 0 M)
	NED:2 (2 F vs. 0 M)	**NED**:2 (1 F vs. 1 M)
	(6 left colonic cancers)	
	(9 sigmoid diverticulitis)	
Mortality at 30 days (%)	0% (0 pts)	0% (0 pts)
Blood transfusion	2 pts	0 pts
Post-op. complications rate (%)	1 pts	0% (0 pts)

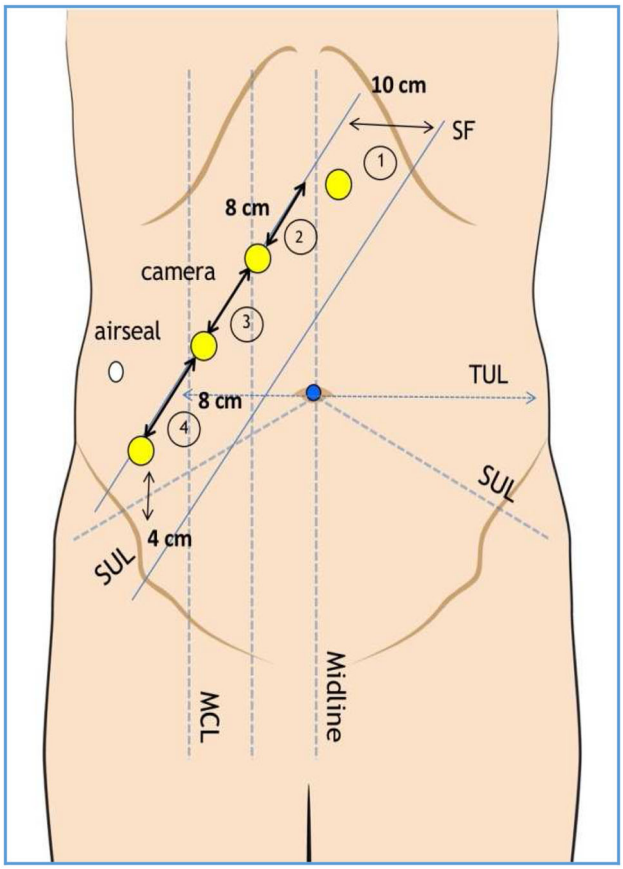

Fig. 3 Ports placement for full robotic RR

intraoperative instruments disposition to avoid tools conflicts and to obtain in any time a better view with no need of changing the robotic docking already assessed or the ports positions, according to the need of managing different and far fields such as splenic flexure and narrow pelvis.

The anastomotic fashioning was performed by different techniques according the stumps length and the most adequate perfusion: side-to-side either side-to-end transanal anastomosis with circular stapler 29 was the most performed.

Regarding the stoma fashioning, in the YG we performed 4 loop ileostomies in addition to the coloanal manual anastomosis, according to the higher risk of anastomotic leakage due to the past neoadjuvant chemo–radiotherapy; furthermore, we prefer loop ileostomy than "on baguette" ileostomy, so the patient can be trained faster in its managing and his discharge cannot be delayed to the inability to start the training due to the baguette maintenance until the 7–8th post-operative day.

The patients demographics as described in Table 5 report a median age for Younger Group (YG) of 57.7 years (range 49–64 years) and median age for Elderly Group (EG) of 81 years (median range 74–92 years), with a prevalence of male gender patients in YG (3 females vs. 4 male) while both genders are equally enrolled in the EG (4 males vs. 4 females).

In the YG, the ASA score was very low; indeed, there was a prevalence of ASA 2 scores (6 pts), added to 1

Table 5 Demographics of patients that underwent full robotic RR

	Young 7	Elderly 8
Age (years)	57.7 years (49–64 years)	81.0 years (74–92 years)
BMI (kg/m)	23.1 (20.2–26.6)	26.3 (17.2–41.5)
Sex	M 4 F 3	M 4 F 4
ASA score	**1**:1 (0 F vs. 1 M)	**1**:0 (0 F vs. 0 M)
	2:6 (3 F vs. 3 M)	**2**:2 (2 F vs. 0 M)
	3:0 (0 F vs. 0 M)	**3**: (2 F vs. 4 M)
	4:0 (0 F vs. 0 M)	**4**:0 (0 F vs. 0 M)

patient for ASA 1, while no patient was assessed as ASA 3 or ASA 4 score. Indeed, in the EG group, no ASA 1 and ASA 4 were determined, while ASA 2 and ASA 3 enrolled, respectively, 2 and 3 patients.

The median BMI in the YG was about 23.1 (range 20.2–26.6) that is lower compared to median BMI of the EG that was 26.3 (range 17.2–41.5).

The robotic RR procedures were performed with the TME technique according to the NCCN guidelines [7] for rectal cancer, as confirmed by histological examination (Table 6): no statistically significant difference has been demonstrated regarding median length of the specimen, YG 22.0 cm (range 18–30 cm) versus EG 20.5 cm (range 13–33 cm); neoplastic distance from both proximal margin YG 17.3 cm (range 13.7–26.5 cm) versus EG 14.3 cm (range 8–24 cm); and distal margin YG 1.8 cm (range 0.5–4.5 cm) versus EG 3.3 cm (range 1.5–8.5 cm).

All the procedures revealed as R0; 4 YG patients underwent neoadjuvant chemo–radiotherapy (45 Gy + capecitabine) while 3 YG patients did not received neoadjuvant therapy due to low cancer stage (c T2 N0) or to the intraperitoneal cancer site. Only 2 EG patients underwent neoadjuvant treatment (1: 45 Gy + capecitabine; 1: radiotherapy alone 25 Gy).

Stomas were fashioned in 5 YG patients: 1 colostomy and 4 loop ileostomies fashioned after very low rectal resections with manual coloanal anastomosis performed. In the EG, we fashioned a total of 6 stomas, 3 loop ileostomies and 3 terminal colostomy (1 after Miles' abdominoperineal resection; 2 Hartmann's resections).

Two EG patients, aware of the risk of incontinence after a low rectal resection, preferred to undergo Hartmann's resections with definitive terminal colostomy.

The cancer median size was similar for both groups YG 4.2 cm (range 2–7.2 cm) versus EG 2.40 cm (range 0.8–4.3 cm); at least 12 lymph nodes were harvested for each patient for both groups: the median number of lymph nodes harvested for YG is 17.2 (range 12–28) versus EG 15.7 (range 12–26).

The post-operative AJCC cancer staging reports for YG 1 pt at Stage I, 1 pt at Stage II, Stage III 3 pts, 1 pt staged as Stage IV. Moreover, 1 patients had no presence of residual malignance, so she was defined as NED. Concerning the AJCC post-operative staging, for EG the results are: 1 pt for Stage I, Stages II and Stage IV and 2 pts for Stage III. Three patients were finally staged as NED while one of them, who suffered from residual adenocarcinoma after a transanal resection, was finally assessed as the persistence of minimal neoplastic patterns.

Looking at the post-operative outcomes (Table 6), according to the small number of patients enrolled, no post-operative mortality and no intraoperative conversion to open or laparoscopic approach were performed. Only 1 male YG patient who underwent RR with no stoma fashioning required reintervention for anastomotic leakage: after the reintervention with Hartmann's procedure, no other complications arose; this patient was the only one been blood transfused in the YG, while no blood transfusion was managed before or after surgery for EG patients.

The systemic outcomes evaluation confirmed no statistically significant differences between the two groups: the median time of first flatus was 3.20 days for YG (range 1–6 days) versus 2.62 days for EG (range 1–5 days), while the soft diet intake required 4.8 days for the YG (range 2–8 days) versus 3.80 days for the YG (range 2–5 days); the median discharge time was for faster than a week, for EG about 5.75 days (range 3–8 days) versus 9.0 days (range 4–13 days) for YG.

Discussion

Colorectal cancer is one of the most frequent malignancies worldwide, especially in elderly people; minimally invasive techniques have been extensively used for the surgical management of this disease during the last two decades, with better short-term outcomes and equivalent oncologic results when compared to open surgery, also in elderly [8–12].

Since September 2014, we performed 50 colorectal full robotic procedures for both malignancies and benign diseases: 15 right colectomies, 20 left colectomies, 15 rectal resection.

We divided the patients in two groups according to the age younger or older than 70 years. The oncological adequacy, as recommended by NCCN guidelines, was respected for all malignancies. The analysis of the systemic outcomes underlines that robotic surgical approach is a feasible, safe and oncological adequate treatment for colorectal disease.

As many authors have already demonstrated, it offers satisfactory systemic outcomes in terms of short hospital stay, early first flatus, quick soft diet intake, good systemic

Table 6 Oncologic and systemic outcomes after full robotic RR

Outcomes	Young 7	Elderly 8
Conversion rate (%)	0 pts	0 pts
Oral soft diet (days)	4.8 days (2–8 days)	3.8 days (2–5 days)
First flatus (days)	3.20 days (1–6 days)	2.62 days (1.5 days)
Discharge (days)	9.0 days (4–13 days)	5.75 (3–8 days)
RT-CHT neoAd.	4	2
	(4: 45 Gy + capectitabine)	(1: 45 Gy + capecitabine) (1: 25 Gy, not CHT)
LNs harvested (n)	17.2 (12–28)	15.7 (12–26)
Specimen length (cm)	22.0 cm (18–30 cm)	20.5 (13–33 cm)
Stoma fashioning	5	6
	(4 loop ileostomies) (1 terminal colostomies)	(3 loop ileostomies) (3 terminal colostomies)
Cancer size (cm)	4.2 cm (2–7.2 cm)	2.4 cm (0.8–4.3 cm)
Proximal margin (cm)	17.3 cm (13.7–26.5 cm)	14.3 cm (8–24 cm)
Distal margin (cm)	1.8 cm (0.5–4.5 cm)	3.3 cm (1.5–8.5 cm)
AJCC stage (n)	**I**:1 (1 F vs. 0 M)	**I**:1 (0 F vs. 1 M)
	II:1 (0 F vs. 1 M)	**II**:1 (1 F vs. 0 M)
	III:3 (0 F vs. 3 M)	**III**:2 (1 F vs. 1 M)
	IV:1 (1 F vs. 0 M)	**IV**:1 (0 F vs. 1 M)
	NED:1 (1 F vs. 0 M)	**NED**:3 (2 F vs. 1 M)
Mortality at 30 days (%)	0% (0 pts)	0% (0 pts)
Blood transfusion	1 pts	0 pts
Post-op. complications rate (%)	1 pts	0% (0 pts)

procedure tolerance, low conversion and post-operative complication rate.

In our experience, limited by the small number of patients enrolled, all these benefits can be demonstrated also for elderly patients, who often present higher ASA score than younger patients due to the co-existent comorbidities; no difference can be revealed between the oncological and the systemic outcomes for both groups.

Conclusions

In our opinion, according to both oncological and functional outcomes obtained in the elderly patients, compatible with the reports of the high-volume robotic centres, the age alone cannot be considered exclusion criteria for robotic surgical approach; moreover, elderly people with comorbidities can benefit of this technological improvement even more than younger patients.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval For this type of study, ethics committee approval is not required.

Statement of human and animal rights All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors.

Informed consent For this type of study, formal consent is not required.

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