Surg Endosc (2016) 30:4372–4382
DOI 10.1007/s00464-016-4755-7

Is laparoscopic surgery really effective for the treatment of colon and rectal cancer in very elderly over 80 years old? A prospective multicentric case–control assessment

Francesco Roscio[1,2] · Luigi Boni[2,3] · Federico Clerici[1] · Paolo Frattini[1] · Elisa Cassinotti[3] · Ildo Scandroglio[1]

Received: 21 August 2015 / Accepted: 11 January 2016 / Published online: 19 February 2016

Abstract
Background To evaluate the effectiveness of laparoscopic surgery (LCS) for colon and rectal cancer in the very elderly over 80 years old.
Methods We performed a prospective multicentric analysis comparing patients over 80 years (Group A) and patients between 60 and 69 years (Group B) undergoing LCS for cancer from January 2008 to December 2013. Colon and rectal cancers were analyzed separately. Comorbidity and complications were classified using the Charlson comorbidity index (CCI) and the Clavien–Dindo system, respectively. Oncological parameters included tumor-free margins, number of lymph nodes harvested and circumferential resection margin.
Results Group A included 96 and 33 patients, and Group B 220 and 82 for colon and rectal cancers, respectively. Groups were similar except for ASA score and CCI, as expected. There was no significant difference in operative time [colon; rectum] (180[IQR 150–200] vs 180[150–210] min; NS—180[160–210] vs 180[165–240] min; NS), estimated blood loss (50[25–75] vs 50[25–120] mL; NS—50[0–150] vs 50[25–108.7] mL; NS) and conversion rate (2.1 vs 2.7 %; NS—3.0 vs 2.4 %; NS). Timing of first stool (3[2–3.25] vs 3[2–5] dd; NS—3[2–4] vs 3[2–5] dd; NS), length of stay (7[6–8] vs 7[6–8] dd; NS—8[8–9] vs 8[7–9] dd; NS) and readmission rate (1.0 vs 0.45 %; NS—6.1 vs 1.2 %; NS) were similar. Tumor-free margins were appropriate, and positivity of CRM is poor (6.1 vs 4.9; NS). We did not record significant differences in complications rate (47.9 vs 43.6 %; NS—63.6 vs 52.4 %; NS).
Conclusions Laparoscopic surgery is effective for the treatment of colorectal cancer even in the very elderly. Age is not a risk factor or a limitation for LCS.

Keywords Laparoscopic surgery · Colon cancer · Rectal cancer · Very elderly

The increase in life expectancy is a distinguishing feature of our society, resulting in higher demand for health and welfare. Colorectal cancer (CRC) is the second most common cancer for both sexes in Western countries, with more than 70 % of cases over 65 years of age [1]. This results in an increasing proportion of elderly and very elderly patients suffering from CRC perspectively candidates for surgery. Since its introduction in 1991 [2], laparoscopic colorectal surgery (LCS) has been validated by studies with level of evidence 1A, which have demonstrated its superiority over traditional surgery for the short-term outcomes and a substantial equality about the functional and oncological results [3–5]. Nevertheless, the diffusion of LCS for CRC in the elderly is still limited and published data need more evidence. The purpose of this study is to analyze the feasibility and effectiveness of LCS for the treatment of colonic and rectal cancers in very elderly, defined as people of 80 years of age or above, comparing the results with a control group consisting of patients aged between 60 and 69 years who underwent same surgery with same indications. Our hypothesis is that

✉ Francesco Roscio
francesco_roscio@yahoo.it

[1] Division of General Surgery, Department of Surgery, Galmarini Hospital, Piazzale A. Zanaboni, 1, 21049 Tradate, Italy

[2] PhD Program in Surgery and Surgical Biotechnologies, University of Insubria, Varese, Italy

[3] Minimally Invasive Surgery Research Center, University of Insubria, Varese, Italy

there are no significant differences in outcomes between cases and controls.

Materials and methods

Data on a consecutive unselected series of patients of 80 years old or greater who underwent laparoscopic surgery for malignant disease of the colon and rectum from January 2008 to December 2013 was prospectively collected and analyzed (*Group A*). The analysis was performed at two institutions (Division of General Surgery, Department of Surgery, Galmarini Hospital, Tradate—IT and Minimally Invasive Surgery Research Center, University of Insubria, Varese—IT), characterized by both a high specific case volume, and the perioperative management complies with international recommendations [6]. These cases were compared with a control group of patients between 60 and 69 years old, who underwent the same surgery, in the same period at the aforementioned two institutions (*Group B*). Procedures for benign disease and under emergency were excluded, while those in election after endoscopic placement of a colonic stent "bridge-to-surgery" were included. Laparoscopic approach is the routine indication at our institutions. Exclusion criteria to laparoscopy were just the unsuitability from an anesthesiological point of view and the dissent from the patient. We considered laparoscopic right colectomies, left colectomies and anterior rectal resections. The group "other" included laparoscopic segmental resections of both transverse colon and splenic flexure, and laparoscopic Miles' procedures, indicated for tumors staged as T2–T4 even after neoadjuvant therapy and located within 2 cm from the anal verge. Rectal tumors in stage II or higher were candidates for long-course 5-fluorouracil-based chemoradiotherapy (CRT; 50.4 Gy in 28 fractions) with surgery scheduled 6–8 weeks after. All patients followed a low-residue and high-calorie diet intake for 5 days before the surgical procedure. The preoperative diagnostic workup included a flexible colonoscopy and a contrast-enhanced computed tomography scan of the abdomen in all patients, a water-soluble contrast enema in case of left colectomy or rectal resection. Data were stored in institutional databases prospectively updated. We analyzed demographics, surgery- and postoperative-related data, as well as the short-term outcomes for each patient. All the considered items are shown in Table 1. Comorbidity of each patient was assessed by Charlson comorbidity index [7]. No patients underwent any bowel preparation except for rectal resection that needed a mechanical bowel preparation using polyethylene glycol 70 + 70 g/2 L the day before surgery. All patients were treated with both short-term broad-spectrum intravenous antibiotics (ceftizoxime plus metronidazole) and antithrombotic prophylaxis by low molecular weight heparin according to body weight. A nasogastric tube and a urinary catheter were placed after induction of general anesthesia in all cases. All the procedures were performed by the same two teams, fully trained in both colorectal and minimally invasive surgery. Surgical instrumentation was standardized, and dissection was performed by harmonic scalpel (Harmonic ACE, Ethicon Endo-Surgery, LLC, Guaynabo, Puerto Rico). All procedures were recorded and stored in digital form.

Surgical technique

All the procedures were performed by a 4-port standardized technique with an approach from medial to lateral. Laparoscopic right colectomy has provided a "high" vascular ligation and an extracorporeal ileocolic anastomosis until 2009–2010, then intracorporeal that is a *totally laparoscopic* right colectomy. For laparoscopic left colectomy and anterior rectal resection, there was a radical ligation of the inferior mesenteric pedicle with preservation of the hypogastric nervous plexus in both sexes. Mobilization of the left colonic flexure was selective in left colectomy, standardized in rectal resection. In case of anterior rectal resection, a total mesorectal excision (TME) was always performed. The anastomosis was transanal and mechanical according to Knight–Griffen technique anyway. In case of cancer of the middle and lower rectum, a loop ileostomy was performed at the end of the procedure. We did not use drains routinely. Postoperative medical and nursing care was standardized. The clinical course was documented for each patient. All patients were mobilized early with removal of the urinary catheter. The nasogastric tube was removed after the first flatus. Criteria for the discharge included the absence of symptoms, tolerance of a minimum of 3 meals without restrictions and passage of stool. All adverse events that occurred within 30 days after surgery were considered complications. Complications were classified using the Clavien–Dindo classification system [8]. The term anastomotic leakage defines all conditions with clinical or radiological anastomotic dehiscence, with or without the need for surgical revision. The proximal and distal clearances from tumor are expressed in centimeters. Regarding rectal surgery, the distal and circumferential resection margins (CRM) are defined positive, that is not adequate, if the clearance is less than 1 cm and 2 mm, respectively. The assessment of mesorectal integrity is expressed as *satisfactory* (intact mesorectum with defects <5 mm, smooth CRM), *partly satisfactory* (moderate irregularities, partial conization, irregular CRM) and *unsatisfactory* (highly incomplete mesorectum, defects reaching the muscle layer, highly irregular CRM) [9].

Table 1 Data analyzed

Type	Item
Demographics, preoperative and disease-related	Age
	Sex
	Body mass index (BMI)[a]
	ASA score[b]
	Charlson comorbidity index
	Previous abdominal surgery
	Type of surgical procedure
	Stage of disease (TNM)[c]
Operative	Operative time
	Estimated blood loss
	Conversion rate
Postoperative	Timing of first stool
	Rate of anastomotic leakage
	Complication rate[d]
	Rate of reoperation
	Hospital stay
	Proximal resection margin[e]
	Distal resection margin[e]
	Number of lymph nodes harvested
	Integrity of mesorectum[f]
	Circumferential resection margin (CRM)[f]
	30-day readmission

[a] kg/m^2

[b] America Society of Anesthesiologists

[c] American Joint Cancer Committee/Union Internationale Contre le Cancer—AJCC/UICC

[d] Clavien–Dindo classification system[127]

[e] Colonic resections

[f] Rectal resections

Short-term follow-up was conducted at 30 days after surgery.

Statistical analysis

Continuous variables were expressed as median and interquartile range (IQR) and then analyzed by nonparametric Mann–Whitney *U* test. Categorical variables were expressed as a percentage and analyzed by Fisher's exact or Chi-square test where appropriate. *P* values <0.05 were considered significant. Statistical analysis was performed using XLSTAT version 2015.1.01 (Addinsoft, New York, USA).

Ethics

The approval of the institutional review committee was not required because the data of the present study were collected in the course of routine clinical practice and, therefore, are considered valid the informed consent signed by each patient for any surgery or other procedure. The study protocol conforms to the ethical guidelines contained in the "World Medical Association Declaration of Helsinki—Ethical Principles for Medical Research Involving Human Subjects" adopted by the 18th WMA General Assembly, Helsinki, Finland, June 1964, then revised in Tokyo 2004 [10].

Results

Colon cancer

Ninety-six patients over 80 years old (Group A) who underwent laparoscopic surgery for colonic cancer were compared with 220 patients aged between 60 and 69 (Group B). Demographics and disease-related data are summarized in Table 2. There were no statistically significant differences by gender, body mass index and previous abdominal surgery between Group A and Group B.

Table 2 Demographics and disease-related data (median [IQR]—#, %)

	Colon cancer			Rectal cancer		
	Group A (>80 yo) $N = 96$	Group B (60–69 yo) $N = 220$	*P*	Group A (>80 yo) $N = 33$	Group B (60–69 yo) $N = 82$	*P*
Age	84 [81–86]	65 [62–67]	**0.001**	84 [82–86]	65 [62–67]	**0.001**
Male/female	55/41 (57.3/42.7)	127/93 (57.7/42.3)	0.942	14/19 (42.4/57.6)	48/34 (58.5/41.5)	0.116
Body mass index[a]	24.2 [20.7–27]	25 [24.4–28]	0.086	24 [22.1–26]	26 [18.3–28]	0.172
ASA score[b]						
I	0	45 (20.4)	**0.001**	0	8 (9.8)	0.062
II	34 (35.4)	133 (60.5)	**0.001**	9 (27.3)	52 (63.4)	**0.004**
III	57 (59.4)	42 (19.1)	**0.001**	22 (66.7)	22 (26.8)	**0.001**
IV	5 (5.2)	0	**0.006**	2 (6.0)	0	**0.024**
Charlson comorbidity index	7 [5–9]	4 [3–5]	**0.001**	7 [5–8]	4 [3–5]	**0.001**
Previous abdominal surgery	66 (68.7)	162 (73.6)	0.372	24 (72.7)	46 (56.1)	0.098
Laparoscopic procedures						
Right colectomy	44 (45.8)	92 (41.8)	0.507			
Left colectomy	38 (39.6)	104 (47.3)	0.206			
ARR[c]				30 (90.9)	78 (95.1)	0.392
Other[d]	14 (14.6)	24 (10.9)	0.355	3 (9.1)	4 (4.9)	0.392
Neoadjuvant therapy				5 (15.2)	19 (23.2)	0.338
T stage[e]						
Tis	0	14 (6.4)	**0.011**	0	0	–
T1	15 (15.6)	27 (12.3)	0.419	3 (9.1)	20 (24.4)	0.063
T2	23 (24.0)	57 (25.9)	0.713	6 (18.2)	32 (39.0)	**0.031**
T3	51 (53.1)	105 (47.7)	0.377	20 (60.6)	22 (26.8)	**0.007**
T4	7 (7.3)	17 (7.7)	0.893	4 (12.1)	8 (9.8)	0.707
N stage						
N0	56 (58.3)	140 (63.6)	0.371	19 (57.6)	59 (72.0)	0.135
N1	23 (24.0)	38 (17.3)	0.166	7 (21.2)	11 (13.4)	0.297
N2	17 (17.7)	42 (19.1)	0.771	7 (21.2)	12 (14.6)	0.390
M stage	89 (92.7)	203 (92.3)	0.893	27 (81.8)	76 (92.7)	0.084
M0						
M1	7 (7.3)	17 (7.7)	0.893	6 (18.2)	6 (7.3)	0.084

Bold values indicate statistical significance

[a] kg/m^2

[b] America Society of Anesthesiologists

[c] Anterior rectal resection

[d] Lap segmental resection of transverse, lap segmental resection of splenic flexure, lap Miles' procedure

[e] American Joint Committee on Cancer/Union Internationale Contre le Cancer

Type of surgical procedures is also comparable. As expected, Group A showed a CCI (7 [IQR 5–9] vs 4 [IQR 3–5]; *P* 0.001) and an ASA score significantly higher than Group B. Regarding the stage of disease, T in situ is more represented in the cohort between 60 and 69 years (0 vs 6.4 %; *P* 0.011). Table 3 shows data related to surgery and short-term outcomes. Mean operative time (180 [IQR 150–200] vs 180 [IQR 150–210] min; NS), estimated blood loss (50 [IQR 25–75] vs 50 [IQR 25–120] mL; NS) and conversion rate (1.0 vs 0 %; NS) are statistically comparable between the two groups. Timing of first stool is quantitatively less for Group A (3 [IQR 2–3.25] vs 3 [IQR 2–5] days; *P* 0.080), although not statistically significant. Anastomotic leakage (1.0 vs 0.9 %; NS), postoperative hospital stay (7 [IQR 6–8] vs 7 [IQR 6–8] days; NS) and the rate of readmission within 30 days after surgery (1.0 vs 0.45 %; NS) are statistically similar. The proximal (7 [IQR 5–10] vs 7 [IQR 5–9] cm; NS) and distal resection margins (9 [IQR 6–12] vs 10 [IQR 8–12] cm; NS), as well as the number of lymph nodes harvested (21 [IQR 15–27] vs 20

Table 3 Short-term outcomes (median [IQR]—#, %)

	Colon cancer			Rectal cancer		
	Group A (>80 yo) $N = 96$	Group B (60–69 yo) $N = 220$	P	Group A (>80 yo) $N = 33$	Group B (60–69 yo) $N = 82$	P
Operative time (min)	180 [150–200]	180 [150–210]	0.139	180 [160–210]	180 [165–240]	0.400
Estimated blood loss (mL)	50 [25–75]	50 [25–120]	0.913	50 [0–150]	50 [25–108.7]	0.505
Conversion rate	2 (2.1)	6 (2.7)	0.737	1 (3.0)	2 (2.4)	0.852
Timing of first stool (dd)[a]	3 [2–3.25]	3 [2–5]	0.080	3 [2–4]	3 [2–5]	0.945
Anastomotic leak	1 (1.0)	2 (0.9)	0.911	2 (6.1)	2 (2.4)	0.337
Reoperation	1 (1.0)	3 (1.4)	0.813	0	1 (1.2)	0.524
Hospital stay (dd)	7 [6–8]	7 [6–8]	0.391	8 [8–9]	8 [7–9]	0.243
Proximal resection margin (cm)	7 [5–10]	7 [5–9]	0.352			
Distal resection margin (cm)	9 [6–12]	10 [8–12]	0.168			
Positive distal resection margin[b]				1 (3.0)	2 (2.4)	0.852
Positive circumferential resection margin[c]				2 (6.1)	4 (4.9)	0.796
Number of lymph nodes harvested	21 [15–27]	20 [14–31]	0.430	18 [12–25]	20.5 [14–24.7]	0.295
Positive lymph nodes	0 [0–2]	0 [0–1]	0.118	0 [0–2]	0 [0–1]	0.093
Mesorectal evaluation						
Satisfactory				30 (90.9)	76 (92.7)	0.748
Partially satisfactory				3 (9.1)	6 (7.3)	0.748
Unsatisfactory				0	0	
30-day readmission	1 (1.0)	1 (0.45)	0.545	2 (6.1)	1 (1.2)	0.140

[a] Patients without loop ileostomy

[b] <1 cm

[c] <2 mm

[IQR 14–31]; NS) are substantially overlapping between Group A and Group B. Complications according to Clavien–Dindo classification system are summarized in Table 4, showing no significant differences.

Rectal cancer

We have analyzed 33 patients aged 80 years old or more (Group A) and 82 controls between 60 and 69 (Group B). Table 2 shows demographics and disease-related data. There are no statistical differences, except for ASA score and CCI (7 [IQR 5–8] vs 4 [IQR 3–5]; P 0.001), significantly higher above 80 years. Group A and Group B show a significant number of T3 (60.6 vs 22 %, P 0.007) and T2 tumors (18.2 vs 39.0 %, P 0.031), respectively. Surgery-related data and short-term outcomes are shown in Table 3. Operative time (180 [IQR 160–210] vs 180 [IQR 165–240] min; NS), estimated blood loss (50 [IQR 0–150] vs 50 [IQR 25–108.7] mL; NS), conversion rate (3.0 vs 2.4 %; NS), timing of first stool (3 [IQR 2–4] vs 3 [IQR 2–5] days; NS), hospital stay (8 [IQR 8–9] vs 8 [IQR 7–9] days; NS) and 30-day readmission rate (6.1 vs 1.2 %; NS) do not differ statistically. The rate of both anastomotic leakage (6.1 vs 2.4 %; NS) and reoperation (0 vs 1.2 %; NS) is well comparable too. About the oncological proficiency, the positivity rate of both the distal margin (3.0 vs 2.4 %; NS) and the CRM (6.1 vs 4.9 %; NS), as well as the number of lymph nodes harvested (18 [IQR 12–25] vs 20.5 [IQR 14–24.7]; NS) is comparable between the two cohorts. The anatomopathological evaluation of the mesorectal specimen does not show any findings classified as *unsatisfactory* in all cases analyzed. The classification of complications is comparable between the two groups, as shown in Table 4.

Discussion

Colorectal cancer (CRC) is the third most common cancer in men (746,000 cases/year, 10.0 % of the total) and the second in women (614,000 cases/year, 9.2 % of the total) worldwide [11]. Statistically, about 4.7 % of the population will have a diagnosis of CRC in lifetime. For example, a man now in his sixties has an estimated risk of developing

Table 4 Complications according to Clavien–Dindo classification system

Grade	Complication	Colon cancer			Rectal cancer		
		Group A (>80 yo) $N = 96$	Group B (60–69 yo) $N = 220$	P	Group A (> 80 yo) $N = 33$	Group B (60–69 yo) $N = 82$	P
Grade I	Total	27 (28.1)	60 (27.7)	0.876	12 (36.4)	31 (37.8)	0.885
	Pain	12 (12.5)	36 (16.4)	0.378	6 (18.2)	10 (12.2)	0.401
	Nausea/vomiting	3 (3.1)	15 (6.8)	0.192	3 (9.1)	7 (8.5)	0.924
	Wound infection	7 (7.3)	12 (5.5)	0.527	1 (3.0)	4 (4.9)	0.660
	Respiratory tract infection	2 (2.1)	2 (0.9)	0.390	0	0	
	Deep vein thrombosis	0	2 (0.9)	0.348	0	0	
	Urinary retention	3 (3.1)	4 (1.8)	0.467	2 (6.1)	7 (8.5)	0.654
	Postoperative ileus	0	0		0	3 (3.6)	0.265
Grade II	Total	16 (17.2)	18 (8.2)	**0.025**	6 (18.2)	9 (11.0)	0.299
	Blood transfusions	15 (15.6)	16 (7.3)	**0.021**	4 (12.1)	7 (8.5)	0.554
	Additional TPN	1 (1.0)	2 (0.9)	0.911	2 (6.1)	2 (2.4)	0.337
Grade IIIa	Total	0	0		1 (3.0)	0	0.113
	Anastomotic leakage	0	0		1 (3.0)	0	0.113
Grade IIIb	Total	1 (1.0)	4 (1.8)	0.611	1 (3.0)	2 (2.4)	0.857
	Anastomotic leakage	1 (1.0)	2 (0.9)	0.911	1 (3.0)	2 (2.4)	0.857
	Hemoperitoneum	0	2 (0.9)	0.348	0	0	
Grade IVa	Total	*0*	*0*		*0*	*0*	
Grade IVb	Total	1 (1.0)	2 (0.9)	0.911	1 (3.0)	1 (1.2)	0.501
	ICU management	1 (1.0)	2 (0.9)	0.911	1 (3.0)	1 (1.2)	0.501
Grade V	Total	*1 (1.0)*	*1 (0.5)*	*0.545*	*0*	*0*	
Total		46 (47.9)	96 (43.6)	0.481	21 (63.6)	43 (52.4)	0.274

Bold values indicate statistical significance

CRC in the next 10 years of 1.26 %, a septuagenarian of 1.96 % and so on [12].

Population aging is a question of primary interest in our society. In Italy, life expectancy at birth in 2011 was 79.4 and 84.5 years, respectively, for males and females, while life expectancy at 65 years old, which is the number of years that a person of that age has still to live on average, is 18.4 for men and 21.9 for women, with no significant geographical differences [13]. Considering that colorectal tumors reach their peak of incidence between the seventh and eighth decade of life, it can be inferred how the amount of elderly patients affected by CRC will be constantly increasing. Surgery plays a pivotal role in the treatment of CRC, although age of patients represents an independent indicator of postoperative morbidity and mortality according to some authors [1, 14]. Surgical treatment is therefore a challenge for this group of patients, due to their frailty caused by reduced physiological reserves and frequent comorbidities [15, 16]. Laparoscopic colorectal surgery (LCS) has shown, with levels of evidence 1A, short-term outcomes better than traditional techniques, due to a substantial reduction in surgical trauma and therefore in the immunological postoperative reaction of the patient. This comes from less handling and exposure of the viscera, together with reduced intraoperative blood loss [17]. The expression of the DR receptor of human leukocyte antigen (HLA-DR) on monocytes remains higher after laparoscopic than conventional colorectal surgery [18], and the seriated measurements of C-reactive protein and interleukin-6 are lower in the 48 h following a laparoscopic procedure, overall indicating a better metabolic response to surgical stress. The long-term analysis after LCS has then highlighted oncological outcomes substantially comparable to open surgery, giving a definitive validation for the minimally invasive treatment of cancers of the colon and, more recently, of the rectum [19–23]. Despite these outcomes, LCS is still much less widespread in the elderly than in younger, because of some considerations limiting the indications. For example, it has been suggested that laparoscopic surgery layout could affect, for extended operating times, a reduction in cardiac output and an increased risk of postoperative atelectasis. But it has been shown that a prolonged pneumoperitoneum or reverse Trendelenburg position of the patient does not cause significant intra- or postoperative problems in patients over 70 years old. Already 10 years ago the guidelines from the

European Association for Endoscopic Surgery (EAES) highlighted how, in patients with a reduced cardio-pulmonary function, laparoscopic surgery is not contraindicated, recommending however to maintain levels of pneumoperitoneum not more than 12 mmHg (Grade of Recommendation B) [24]. The percentage of elderly patients included in the trials published on LCS is limited. Out of 52 study protocols available today, 44 % exclude the elderly simply because of age or comorbidities. In 86 % of trials, the mean age of patients enrolled is below 70 years of age without any specification of concomitant comorbidities [25]. There are some limitations related to the age of patients even in clinical practice. A Dutch population-based analysis over 33,000 patients showed that the rate of LCS for cancer still registers a statistically significant difference in distribution between patients under and over 75 years of age (49.2 vs 40.3 %) [26]. Hence, we need to clarify the effectiveness of LCS in the elderly population, whose results are shown in Tables 5 and 6, respectively, as results of LCS in elderly versus younger and outcomes of LCS versus open surgery in elderly patients. The age limit to indicate the elderly patient is difficult to define worldwide, and it often shows some differences even in developed countries. Conventionally, recent literature has indicated 70 years as the cutoff to determine this limit, although a shared definition is not yet reached. Most of the authors retrospectively compared open and laparoscopic colorectal surgery over a limit of age varying between 65 and 85 years. However, this method of comparison could highlight a selection bias, when the criteria for the choice of a type of surgery over another are not well specified [27], or when both previous abdominal surgery and locally advanced diseases constitute criteria for the exclusion of patients from the laparoscopic cohort [28]. Few papers analyzed the outcomes of LCS in the elderly compared to younger patients. However, in the study of Schwandner et al., the two cohorts were not well comparable in terms of surgical procedures [29], while Reissman et al. used an inadequate aging cutoff fixed at 60 years [30]. The paper by Yamamoto et al. was methodologically correct, although the small sample size has weakened the statistical significance [31]. Those by Chautard et al. [32] and Keller et al. [33], with a cutoff of 70 years, have shown outcomes substantially comparable between young and elderly patients undergoing LCS, although the second one included patients with benign disease for the 60 % of young patients and 40 % of the elderly. The research from Jeong et al., with an age limit of 75 years, showed a significantly higher rate of complications in elderly patients (12 vs 6.2 %) and therefore concluded that age represented an independent predictor of postoperative morbidity [34]. Papers concerning very elderly patients over 80 years of age are rare. Steward et al. and Lian *et al.* on the one hand, Mukai *et al.* and Nakamura et al. on the other, compared LCS and open surgery with a cutoff fixed at 80 and 85 years, respectively, highlighting

Table 5 Laparoscopic colorectal surgery in the elderly compared to younger patients

Author	Year	*N*	Age	Conversion rate (%)	Morbidity (%)	Mortality (%)	Hospital stay (dd)
Reissman [30]	1996	36	<60	8.0	11.0	0	5.2
		36	>60	11.0	14.0	0	6.5
Schwandner [29]	1999	65	<50	3.1	4.6	–	11.5
		138	50–70	9.4	10.1	–	13.3
		95	>70	7.4	9.5	–	17.2
Yamamoto [31]	2003	34	<60	0	23.5	0	9.0
		17	>80	0	11.7	0	10.0
Chautard [32]	2008	103	<70	16.0	27.0	0	10 ± 9
		75	>70	21.0	32.0	0	11 ± 8
Tan [48]	2011	379	<70	8.0	13.0	0.3	–
		91	>75	7.0	15.0	3.0	–
Roscio [49]	2011	101	<70	2.0	3.8	0	8.1 ± 2.8
		58	>70	1.7	3.4	1.7	10.8 ± 6.6
Jeong [34]	2013	824	<75	–	6.2	0	–
		92	>75	–	12.0	0	–
Keller [33]	2013	302	<70	–	12.6	0	–
		153	>70	–	16.9	0	–

LCS laparoscopic colorectal surgery

Table 6 Laparoscopic versus open colorectal surgery in the elderly

Author	Year	Technique	*N*	Age	Conversion rate (%)	Morbidity (%)	Mortality (%)	Hospital stay (dd)
Steward [35]	1999	LCS	42	>80	11.9	16.6	7.1	9.0
		OCS	35	>80		42.8	11.4	17.0
Delgado [50]	2000	LCS	70	<70	11.4	11.4	0	5 ± 2
		OCS	59	<70		20.3	0	7 ± 3
		LCS	59	>70	16.9	10.0	1.6	6 ± 2
		OCS	67	>70		31.3	0	7 ± 3
Stocchi [51]	2000	LCS	42	>75	14.3	14.3	0	6.5
		OCS	42	>75		33.3	0	10.2
Law [52]	2002	LCS	65	>70	12.3	27.7	1.5	7.0
		OCS	89	>70		37.0	5.6	9.0
Senagore [53]	2003	LCS	181	<60	–	10.5		3.9 ± 5.9
		OCS	122	<60		13.1		6.1 ± 3.0
		LCS	50	>70	–	16.0		4.2 ± 3.0
		OCS	123	>70		37.4		9.3 ± 7.6
Sklow [54]	2003	LCS	38	<75	16.0	29.0		6.7
		OCS	38	<75		37.0		7.7
		LCS	39	>75	8.0	31.0	2.6	3.9
		OCS	39	>75		31.0		4.9
Vignali [55]	2005	LCS	61	>80	6.1	21.5	1.6	–
		OCS	61	>80		31.1	3.2	–
Feng [56]	2006	LCS	51	>70	3.9	17.6	0	–
		OCS	102	>70		37.3	1.9	–
Lian [36]	2010	LCS	97	>80	14.4	–	5.2	6.0
		OCS	97	>80		–	5.2	7.0
She [57]	2013	LCS	189	>75	4.8	20.6	0.5	5.0
		OCS	245	>75		28.6	4.0	7.0
Mukai [40]	2014	LCS	44	>85	0	13.6	0	14.7
		OCS	37	>85		27.0	0	21.7
Nakamura [41]	2014	LCS	34	>85	–	18.0	0	10.0
		OCS	46	>85	–	30.0	0	19.0

LCS laparoscopic colorectal surgery

OCS open colorectal surgery

significant results in terms of length of hospital stay and morbi-mortality in favor of minimally invasive surgery [35–38]. In this study, we tried to rigorously define the methodology of selection for both cases and controls. We chose octogenarians cases who, for uniformity of characteristics, better represented the object of an analysis about the effectiveness of LCS in the elderly. Then, we considered a group of controls limited in age between 60 and 69 years, as a very significant decade for the epidemiological impact of CRC, representing a cohort of controls neither too young nor too close to the group of cases, so as to minimize the risk of bias for the analysis. The cohorts analyzed were found to be uniform regarding both the surgical treatment and the perioperative management. All the procedures were performed by minimally invasive technique, which is of choice for us, regardless of limits of inclusion related to comorbidities or disease's stage. As expected, the groups differed regarding both the preoperative assessment by the America Society of Anesthesiologists score and the index of comorbidities. This latter aspect has been evaluated by Charlson comorbidity index through 19 tracer conditions corresponding to different scores, complemented by an additional set of values for decades of age. This score is derived from internal medicine but represents a useful tool to weigh the comorbidity of compared groups and to estimate the postoperative morbidity and mortality. In fact, the surgical risk is directly proportional to the comorbidities of patients, and, as noted in the original work by Charlson, a score greater than 3 doubles 1-year mortality risk [7].

Referring to the stage of disease, colonic cancers showed a significantly greater rate of in situ tumors in Group B (0 vs 6.4 %). Cancers of rectum instead showed a higher number of T2 tumors in the arm between 60 and 69 years (18.2 vs 39.0 %), while Group A showed a higher proportion of T3 tumors (60.6 vs 26.8 %), probably in relation to the reduced rate of neoadjuvant therapy in this cohort (15.2 vs 20.2 %). Colonic and rectal cancers show anatomical and pathophysiological similarities; however, there are some differences in epidemiological, clinical and therapeutic matters that have suggested a differentiated analysis. Surgical treatment of rectal cancer seems to be more challenging, especially in the presence of patients with narrow pelvis or bulking tumors. A proper surgical technique is directly related to both functional and oncological outcomes. Recognition and respect of the hypogastric plexus and its branches allow the maintenance of a quality of life even in the elderly, so also it is well known how a proficient surgery gets good long-term outcomes in terms of local and systemic recurrences as well as disease-free and overall survival [39]. Therefore, a great care has been taken in the analysis of the specimens.

For colonic cancer surgery, through the assessment of both the number of lymph nodes harvested and the clearance of resection margins, which should, respectively, be at least of 14 nodes and 2 cm [6].

Regarding rectal cancer, as well as through the analysis of the items mentioned above, with a minimum cutoff of 1 cm for the resection margin of lower rectum cancers, in addition we checked the integrity of mesorectum excised using the methodology proposed by the Belgian group PROCARE [40], and we evaluated the circumferential resection margin (CRM). CRM is an accurate predictor of local recurrence, with a prognostic value independent of TNM classification. Our analysis has provided a positive CRM cutoff less than 2 mm, which, if negative, should reduce the risk of local recurrence (5.8 % compared to 16.0 % in the case of positive 2-mm CRM) [41]. The same limit was applied for the COLOR II study, showing a positive CRM in 9.9 % of cases [42], while other trials have defined as positive a CRM less than 1 mm, resulting in 15.1 % in the MRC-CLASICC [43] and in 3.5 % in COREAN trial [44]. The comparison of these data with the results reported by us (6.1 vs 4.9 %; NS) emphasized the effectiveness of rectal surgical resections for both cases and controls. Groups A and B showed no statistically significant differences for either colonic or rectal cancer in terms of operative time (180 [IQR 150–200] vs 180 [IQR 150–210] min; NS—180 [IQR 160–210] vs 180 [IQR 165–240] min; NS), intraoperative blood loss (50 [IQR 25–75] vs 50 [IQR 25–120] mL; NS—50 [IQR 0–150] vs 50 [IQR 25–108.7] mL; NS) and conversion rate (2.1 vs 2.7 %; NS—3.0 vs 2.4 %; NS). Short-term outcomes of LCS are well known and supported by level 1A evidence [45–47]. This study showed that these results can be achieved even in very elderly patients over 80 years of age. Timing of first stool (3 [IQR 2–3.25] vs 3 [IQR 2–5] days; NS—3 [IQR 2–4] vs 3 [IQR 2–5] days; NS), length of hospital stay (7 [IQR 6–8] vs 7 [IQR 6–8] days; NS—8 [IQR 8–9] vs 8 [IQR 7–9] days; NS) and 30-day readmission rate (1.0 vs 0.45 %; NS—6.1 vs 1.2 %; NS) revealed no significant differences between age groups, similar to literature data. Even the postoperative morbidity and mortality rate were statistically comparable between elderly and 60- to 69-year-old patients, for both colonic (47.9 vs 43.6 %; NS) and rectal (63.6 vs 52.4 %; NS) cancers. The high rate of complications was substantially due to the choice of the Clavien–Dindo classification system [10]. This tool stratifies complications in five grades of severity, depending on the type of treatment. This minimizes the risk of bias and allows a rigorous method of comparison between the series in the literature, otherwise difficult using the classical categorization in minor and major complications. Grades I and II include only minor deviations from the normal postoperative course, which could be solved by drug therapy, blood transfusions, total parenteral nutrition and placement of simple devices such as a urinary catheter and nasogastric tube. Grades III and IV instead collect severe complications, which require a surgical, endoscopic or radiological interventional treatment, rather than ICU management. Almost all of the postoperative complications of our series fell in Clavien–Dindo grades I and II, with only a significant difference consisting in a higher rate of blood transfusions in the arm over 80 years underwent laparoscopic colonic surgery, likely due to an increased comorbidity rate.

Conclusions

Laparoscopic surgery is effective and safe for the treatment of colonic and rectal cancer even in very elderly over 80 years old. Short-term outcomes and results in terms of oncological proficiency are similar to those from the control group between 60 and 69 years old. Age does not appear to be a risk factor or a limitation for laparoscopic colorectal surgery, and indeed, very elderly patients may benefit from a minimally invasive approach.

Compliance with ethical standards

Disclosures Francesco Roscio, Luigi Boni, Federico Clerici, Paolo Frattini, Elisa Cassinotti and Ildo Scandroglio have no conflicts of interest or financial ties to disclose.

References

1. Colorectal Cancer Collaborative Group (2000) Surgery for colorectal cancer in elderly patients: a systematic review. Lancet 356:968–974
2. Jacobs M, Verdeja JC, Goldstein HS (1991) Minimally invasive colon resection (laparoscopic colectomy). Surg Laparosc Endosc 1(3):144–150
3. Schwenk W, Haase O, Neudecker JJ, Müller JM (2005) Short term benefits for laparoscopic colorectal resection. Cochrane Database Syst Rev 3:CD003145
4. Kuhry E, Schwenk WF, Gaupset R, Romild U, Bonjer HJ (2008) Long-term results of laparoscopic colorectal cancer resection. Cochrane Database Syst Rev 2:CD003432
5. Breukink S, Pieride JP, Wiggers T (2006) Laparoscopic versus open total mesorectal excision for rectal cancer. Cochrane Database Syst Rev 4:CD005200
6. Zerey M, Hawver LM, AwadZ Stefanidis D, Richardson W, Fanelli RD, Members of the SAGES Guidelines Committee (2013) Guidelines for laparoscopic resection of curable colon and rectal cancer. Surg Endosc 27:1–10
7. Charlson ME, Pompei P, Ales KL, MacKenzie CR (1987) A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chron Dis 40:373–383
8. Dindo D, Demartines N, Clavien PA (2004) Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 240:205–213
9. PROCARE: multidisciplinary Belgian PROject on CAncer of the Rectum. Multidisciplinary guidelines for the treatment of rectal cancer can be downloaded from www.kankerregister.be or www.registreducancer.be
10. World Medical Association (WMA) Declaration of Helsinki—ethical principles for medical research involving human subjects. http://www.wma.net/en/30publications/10policies/b3/index.html. Accessed 22 Feb 2014
11. World Health Organization—Globocan (2012) Estimated incidence, mortality and prevalence worldwide in 2012. http://globocan.iarc.fr/Pages/fact_sheets_cancer.aspx
12. Howlader N, Noone AM, Krapcho M, Garshell J, Miller D, Altekruse SF, Kosary CL, Yu M, Ruhl J, Tatalovich Z, Mariotto A, Lewis DR, Chen HS, Feuer EJ, Cronin KA (2015) SEER Cancer Stat Rev 1975–2011. National Cancer Institute, Bethesda, MD. http://seer.cancer.gov/csr/1975_2011/. Updated December 17, 2014
13. http://www.demo.istat.it/altridati/indicatori/2011/Tab_5.pdf
14. Masoomi H, Kang CY, Chen A, Mills S, Dolich MO, Carmichael JC, Stamos MJ (2012) Predictive factors of in-hospital mortality in colon and rectal surgery. J Am Coll Surg 215:255–261
15. Tan KJ, Kawamura YJ, Tokomitsu A, Tang T (2012) Assessment for frailty is useful for predicting morbidity in elderly patients undergoing colorectal cancer resection whose comorbidities are already optimized. Am J Surg 204:139–143
16. Diamantini G, Rossi P, Caciolo F, Levi Sandri GB, Procacciante F (2015) Colorectal surgery for cancer in very elderly patient. Int J Colorectal Dis. doi:10.1007/s00384-014-2106-5
17. Hiki N, Shimizu N, Yamaguchi H, Imamura K, Kami K, Kubota K, Kaminishi M (2006) Manipulation of the small intestine as a cause of the increased inflammatory response after open compared with laparoscopic surgery. Br J Surg 93:195–204
18. Veenhof AA, Vlug MS, Van der Pas MH, Sietses C, Van der Peet DL, de Lange-de Klerk ES, Bonjer HJ, Bemelman WA, Cuesta MA (2012) Surgical stress response and postoperative immune function after laparoscopy or open surgery with fast track or standard perioperative care: a randomized trial. Ann Surg 255:216–221
19. Fleshman J, Sargent DJ, Green E, Anvari M, Stryker SJ, Beart RW Jr, Hellinger M, Flanagan R Jr, Peters W, Nelson H, Clinical Outcomes of Surgical Therapy Study Group (2007) Laparoscopic colectomy for cancer is not inferior to open surgery based on 5-year data from the COST Study Group trial. Ann Surg 246:655–662
20. Jayne DG, Thorpe HC, Copeland J, Quirke P, Brown JM, Guillou PJ (2010) Five-year follow-up of the Medical Research Council CLASICC trial of laparoscopically assisted versus open surgery for colorectal cancer. Br J Surg 97:1638–1645
21. Colon Cancer Laparoscopic or Open Resection Study Group, Buunen M, Veldkamp R, Hop WC, Kuhry E, Jeekel J, Haglind E, Påhlman L, Cuesta MA, Msika S, Morino M, Lacy A, Bonjer HJ (2009) Survival after laparoscopic surgery versus open surgery for colon cancer: long-term outcome of a randomised clinical trial. Lancet Oncol 10:44–52
22. Lacy AM, Delgado S, Castells A, Prins HA, Arroyo V, Ibarzabal A, Pique JM (2008) The long-term results of a randomized clinical trial of laparoscopy-assisted versus open surgery for colon cancer. Ann Surg 248:1–7
23. Jeong SY, Park JW, Nam BH, Kim S, Kang SB, Lim SB, Choi HS, Kim DW, Chang HJ, Kim DY, Jung KH, Kim TY, Kang GH, Chie EK, Kim SY, Sohn DK, Kim DH, Kim JS, Lee HS, Kim JH, Oh JH (2014) Open versus laparoscopic surgery for mid-rectal or low-rectal cancer after neoadjuvant chemoradiotherapy (COREAN trial): survival outcomes of an open-label, non-inferiority, randomised controlled trial. Lancet Oncol 15:767–774
24. Veldkamp R, Gholghesaei M, Bonjer HJ, Meijer DW, Buunen M, Jeekel J, Anderberg B, Cuesta MA, Cuschierl A, Fingerhut A, Fleshman JW, Guillou PJ, Haglind E, Himpens J, Jacobi CA, Jakimowicz JJ, Koeckerling F, Lacy AM, Lezoche E, Monson JR, Morino M, Neugebauer E, Wexner SD, Whelan RL, European Association of Endoscopic Surgery (EAES) (2004) Laparoscopic resection of colon Cancer: consensus of the European Association of Endoscopic Surgery (EAES). Surg Endosc 18:1163–1185
25. Schiphorst AH, Pronk A, Borel Rinkes IH, Hamaker ME (2014) Representation of the elderly in trials of laparoscopic surgery for colorectal cancer. Colorectal Dis 16:976–983
26. Hamaker ME, Schiphorst AH, Verweij NM, Pronk A (2014) Improved survival for older patients undergoing surgery for colorectal cancer between 2008 and 2011. Int J Colorectal Dis 29:1231–1236
27. Miyasaka Y, Mochidome N, Kobayashi K, Ryu S, Akashi Y, Miyoshi A (2014) Efficacy of laparoscopic resection in elderly patients with colorectal cancer. Surg Today 44:1834–1840
28. Hatakeyama T, Nakanishi M, Murayama Y, Komatsu S, Shiozaki A, Kuriu Y, Ikoma H, Ichikawa D, Fujiwara H, Okamoto K, Ochiai T, Kokuba Y, Otsuji E (2013) Laparoscopic resection for colorectal cancer improves short-term outcomes in very elderly colorectal cancer patients. Surg Laparosc Endosc Percutan Tech 23:532–535
29. Schwandner O, Schiedeck THK, Bruch HP (1999) Advanced age—indication or contraindication for laparoscopic colorectal surgery? Dis Colon Rectum 42:356–362
30. Reissman P, Agachan F, Wexner SD (1996) Outcome of laparoscopic colorectal surgery in older patients. Am Surg 62:1060–1063
31. Yamamoto S, Watanabe M, Hasegawa H, Baba H, Kitajima M (2003) Short-term surgical outcomes of laparoscopic colonic surgery in octogenarians. A matched case–control study. Surg Laparosc Endosc Percutan Tech 13:95–100
32. Chautard J, Alves A, Zalinski S, Bretagnol F, Valleur P, Panis Y (2008) Laparoscopic colorectal surgery in elderly patients: a matched case–control study in 178 patients. J Am Coll Surg 206:255–260
33. Keller DS, Lawrance JK, Nobel T, Delaney CP (2013) Optimizing cost and short-term outcomes for elderly patients in laparoscopic colonic surgery. Surg Endosc 27:4463–4468

34. Jeong DH, Hur H, Soh Min B, Baik SH, Kim NK (2013) Safety and feasibility of a laparoscopic colorectal cancer resection in elderly patients. Ann Coloproctol 29:22–27
35. Stewart BT, Stitz RW, Lumley JW (1999) Laparoscopically assisted colorectal surgery in the elderly. Br J Surg 86:938–941
36. Lian L, Kalady M, Geisler D, Kiran R (2010) Laparoscopic colectomy is safe and leads to a significantly shorter hospital stay for octogenarians. Surg Endosc 24:2039–2043
37. Mukai T, Akiyoshi T, Ueno M, Fukunaga Y, Nagayama S, Fujimoto Y, Konishi T, Ikeda A, Yamaguchi T (2014) Outcomes of laparoscopic surgery for colorectal cancer in oldest-old patients. Surg Laparosc Endosc Percutan Tech 24:366–369
38. Nakamura T, Sato T, Miura H, Ikeda A, Tsutsui A, Naito M, Ogura N, Watanabe M (2014) Feasibility and outcomes of surgical therapy in very elderly patients with colorectal cancer. Surg Laparosc Endosc Percutan Tech 24:85–88
39. Heald RJ, Moran BJ, Ryall RDH, Sexton R, MacFarlane JK (1998) Rectal cancer: the Basingstoke experience of total mesorectal excision, 1978–1997. Arch Surg 133:894–899
40. Leonard D, Penninckx F, Fieuws S, Jouret-Mourin A, Sempoux C, Jehaes C, Van Eycken E, PROCARE, a Multidisciplinary Belgian Project on Cancer of the Rectum (2010) Factors predicting the quality of total mesorectal excision for rectal cancer. Ann Surg 252:982–988
41. Nagtegaal ID, Marijnen CA, Kranenbarg EK, van de Velde CJ, van Krieken JH, Pathology Review Committee, Cooperative Clinical Investigators (2002) Circumferential margin involvement is still an important predictor of local recurrence in rectal carcinoma: not one millimeter but two millimeters is the limit. Am J Surg Pathol 26:350–357
42. Van der Pas MH, Haglind E, Cuesta MA, Fürst A, Lacy AM, Hop WC, Bonjer HJ, COlorectal cancer Laparoscopic or Open Resection II (COLOR II) Study Group (2013) Laparoscopic versus open surgery for rectal cancer (COLOR II): short-term outcomes of a randomised, phase 3 trial. Lancet Oncol 14:210–218
43. Guillou PJ, Quirke P, Thorpe H, Walker J, Jayne DG, Smith AM, Heath RM, Brown JM, MRC CLASICC Trial Group (2005) Short-term endpoints of conventional versus laparoscopic-assisted surgery in patients with colorectal cancer (MRC CLASICC trial): multicentre, randomised controlled trial. Lancet 365:1718–1726
44. Kang SB, Park JW, Jeong SY, Nam BH, Choi HS, Kim DW, Lim SB, Lee TG, Kim DY, Kim JS, Chang HJ, Lee HS, Kim SY, Jung KH, Hong YS, Kim JH, Sohn DK, Kim DH, Oh JH (2010) Open versus laparoscopic surgery for mid or low rectal cancer after neoadjuvant chemoradiotherapy (COREAN trial): short-term outcomes of an open-label randomised controlled trial. Lancet Oncol 11:637–645
45. Clinical Outcomes of Surgical Therapy Study Group (2004) A comparison of laparoscopically assisted and open colectomy for colon cancer. N Engl J Med 350:2050–2059
46. Veldkamp R, Kuhry E, Hop WC, Jeekel J, Kazemier G, Bonjer HJ, Haglind E, Påhlman L, Cuesta MA, Msika S, Morino M, Lacy AM, COlon cancer Laparoscopic or Open Resection Study Group (COLOR) (2005) Laparoscopic surgery versus open surgery for colon cancer: short-term outcomes of a randomised trial. Lancet Oncol 6:477–484
47. Lacy AM, García-Valdecasas JC, Delgado S, Castells A, Taurá P, Piqué JM, Visa J (2002) Laparoscopy-assisted colectomy versus open colectomy for treatment of non-metastatic colon cancer: a randomised trial. Lancet 359:2224–2229
48. Tan KY, Konishi F, Kawamura YJ, Maeda T, Sasaki J, Tsujinaka S, Horie H (2011) Laparoscopic corectal surgery in elderly patients: a case-control study of 15 years of experience. Am J Surg 20:531–536
49. Roscio F, Bertoglio C, De Luca A, Frigerio A, Galli F, Scandroglio I (2011) Outcomes of laparoscopic surgery for colorectal cancer in elderly patients. JSLS 15:315–321
50. Delgado S, Lacy AM, García-Valdecasas JC, Balaqué C, Pera M, Salvador L, Monblan D, Visa J (2000) Could age be an indication for laparoscopic colectomy in colorectal cancer? Surg Endosc 14:22–26
51. Stocchi L, Nelson H, Young-Fadok TM, Larson DR, Ilstrup DM (2000) Safety and advantages of laparoscopic vs. open colectomy in the elderly: matched-control study. Dis Colon Rectum 43:326–332
52. Law WL, Chu KW, Tung P (2002) Laparoscopic colorectal resection: a safe option for elderly patients. J Am Coll Surg 195:768–773
53. Senagore A, Madbouly K, Fazio V, Duepree H, Brady K, Delaney C (2003) Advantages of laparoscopic colectomy in older patients. Arch Surg 138:252–256
54. Sklow B, Read T, Birnbaum E, Fry R, Fleshman J (2003) Age and type of procedure influence the choice of patients for laparoscopic colectomy. Surg Endosc 17:923–929
55. Vignali A, Di Palo S, Tamburini A, Radaelli G, Orsenigo E, Staudacher C (2005) Laparoscopic vs. open colectomies in octogenarians: a case-matched control study. Dis Colon Rectum 48:2070–2075
56. Feng B, Zheng MH, Mao ZH, Li JW, Lu AG, Wang ML, Hu WG, Dong F, Hu YY, Zang L, Li HW (2006) Clinical advantages of laparoscopic colorectal cancer surgery in the elderly. Aging Clin Exp Res 18:191–195
57. She WH, Poon JTC, Fan JKM, Lo OSH, Law WL (2013) Outcome of laparoscopic colectomy for cancer in elderly patients. Surg Endosc 27:308–312