

ORIGINAL ARTICLE

Outcomes of conversion from laparoscopy to open surgery in geriatric patients with colorectal cancer: a case-control study

Nuri Okkabaz¹, Merih Yilmaz², Osman Civil¹, Mustafa Haksal², Mustafa Oncel²

¹Department of General Surgery, Kartal Education and Research Hospital, Istanbul, Turkey; ²Department of Oncological & Colorectal Surgery, Istanbul Medipol University Medical School, Istanbul, Turkey.

Summary

Purpose: To evaluate the incidence, risk factors and outcomes of conversion from laparoscopic to open surgery in geriatric patients with colorectal cancer (CRC).

Methods: All patients subjected to laparoscopic procedures for CRC between 2006 and 2018 were included. Patients older than 70 were divided into those necessitating or not necessitating conversion to open surgery (Con>70 and Lap>70 groups, respectively), and those younger than 70 requiring conversion were evaluated in Con<70 group. The results were compared between Con>70 group and the two other groups.

Results: Conversion was significantly more common in Con>70 group than Con<70 group (17.3 vs 9.6%, $p=0.011$). Although female gender and T4 tumors leading to multivisceral resection were significant risk factors for conversion in univariate analysis, multivariate analysis denied any variable as significant.

Perioperative outcomes were significantly worse in Con>70 group than those in Lap>70 group. When conversion groups were compared, the rates of surgical site infection and evisceration were higher in geriatric patients. Pathological results revealed that Con>70 group had more advanced tumors than Lap>70 group regarding pT stage, number of malignant lymph nodes and perineural invasion rate. However, the numbers of harvested lymph nodes were similar in two groups.

Conclusion: Conversion rate is higher in geriatric patients, particularly in female patients and those who necessitate multivisceral resections. Conversion worsens the perioperative outcomes in geriatric patients. Finally, since the number of harvested lymph nodes does not decrease with conversion, it probably does not threaten the quality of oncological surgery.

Key words: colorectal cancer, laparoscopy, conversion, geriatric, outcome

Introduction

CRC is a commonly encountered disease, with approximately 1.5 million new cases annually diagnosed [1]. Many randomized and observational studies have reported that laparoscopic colectomy is equivalent or superior to open technique regarding short-term outcomes, and both procedures have comparable oncological outcomes [2-5]. However, conversion of laparoscopic to open surgery occurs in up to 41% of the cases, as reported in prospective studies, and a recent prospective randomized trial has revealed a conversion rate as high as 9.7% [6,7]. Conversion may worsen the outcomes of laparos-

copy, including postoperative complications, surgical site infection (SSI), anastomotic leak, mortality rate, length of hospital stay, and oncological results [8-15].

The number of geriatric patients suffering from CRC has been increasing probably because of prolonged life expectancy [5]. A recent meta-analysis and several other studies (including one from our institution) have shown the feasibility and benefit of laparoscopy in geriatric patients because minimally invasive surgery is associated with improved short- and long-term outcomes [5,16,17].

Corresponding author: Nuri Okkabaz, MD. Merkez Mh., Dr. Sadik Ahmet Caddesi, 34100 Bagcilar, Istanbul, Turkey.
Tel: +90 5063438750, Email: n_okkabaz@yahoo.com
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Consequences of conversion and the outcomes of laparoscopic surgery for the management of CRC have been well studied; however, there is limited information regarding risk factors and outcomes of conversion in patients aged >70 years [18-21]. Thus, the present retrospective study aimed to investigate the rate, risk factors, and outcomes of conversion in geriatric patients with colorectal cancer using two independent analyses.

Methods

All patients diagnosed with CRC who were subjected to laparoscopic surgery at the Kartal Education and Research Hospital between 2006 and 2012 or at the Department of Oncological & Colorectal Surgery at the Istanbul Medipol University, Medical School, between 2012 and 2018 were retrieved from a prospective database. A senior surgeon (MO) operated or supervised all procedures. Prior to the initiation of data retrieval, Istanbul Medipol University Ethics Committee approved the study (IRB number: 10840098-604.01.01-E21335). The study was also registered at www.researchregistry.com (research registry3925). To assess the outcomes of conversion

in geriatric patients, the analysis was designed as one study and two comparison groups. The study group included patients aged >70 years who required conversion to open surgery (Con >70 group) [n=27; 17 (63%) females with median age of 77 (range, 70-86) years], and the comparison groups involved patients aged >70 years who did not require conversion (Lap >70 group) [n=129; 49 (38%) females with a median age of 75 (range, 70-89) years] and those aged <70 years who required conversion (Con <70 group) [n=52; 18 (34.6%) females with a median age of 56.5 (range, 21-67) years].

The previously mentioned prospective database was scanned for all eligible patients, and cases with operation for benign conditions or premalignant lesions, including polyps or *in situ* carcinomas, were not included. In addition, those who received a palliative procedure (such as a diverting colostomy or exploration of the abdominal cavity because of carcinomatosis) or those who had an urgent resection were also excluded from further analyses. The procedure was defined as conversion if the intended laparoscopic steps were not laparoscopically completed and/or if an extension in the preoperatively planned incision size was necessary to complete any phase of the operation.

Outcome measures were compared between the Con >70 and Lap >70 groups and between the Con >70 and

Table 1. Patient characteristics, neoadjuvant radiation therapy status, and tumor location

Variables	Con>70 (n=27) n (%)	Lap>70 (n=129) n (%)	p	Con<70 (n=52) n (%)	p
Gender (females) (%)	17 (63)	49 (38)	0.017	18 (34.6)	0.016
Age, years, median (range)	77 (70-86)	75 (70-89)	0.350	56.5 (21-67)	<0.001
Previous abdominal operation	6 (22.2)	36 (27.9)	0.545	15 (28.8)	0.527
ASA score			0.958		0.66
1	0	3 (2.3)		7 (13.7)	
2	14 (51.9)	66 (51.2)		29 (56.9)	
3	13 (48.1)	56 (43.4)		15 (29.4)	
4	0	4 (3.1)		0	
Concomitant diseases	15 (55.6)	90 (69.8)	0.152	19 (36.5)	0.105
Hypertension	13 (48.1)	64 (49.6)	0.890	11 (21.2)	0.013
Diabetes mellitus	7 (25.9)	28 (21.7)	0.633	6 (11.5)	0.119
CAD/CHF	4 (14.8)	29 (22.5)	0.239	4 (7.7)	0.685
COPD	2 (7.4)	3 (8.3)	0.701	3 (5.8)	0.999
CKD	0	5 (3.9)	0.588	0	NA
Previous CVA	0	4 (3.1)	0.999	0	NA
Previous malignancy	0	4 (3.1)	0.999	2 (3.8)	0.544
Neoadjuvant radiation therapy ^a	9 (90) (n=10)	17 (27.4) (n=64)	0.434	15 (62.5) (n=24)	0.215
Tumor location			0.665		0.726
Ascending colon	6 (22.2)	26 (20.2)		9 (17.3)	
Transverse colon	2 (7.4)	11 (8.5)		6 (11.5)	
Descending colon	9 (33.3)	28 (21.7)		13 (25)	
Rectum	10 (37.0)	64 (49.6)		24 (46.2)	

ASA: American Society of Anesthesiologists, CAD: Coronary artery disease, CHF: Congestive heart failure, COPD: chronic obstructive pulmonary disease, CKD: Chronic kidney disease, CVA: cerebrovascular accident, NA: not applicable

^a For rectal cancers only

Con <70 groups and included demographics, the American Society of Anesthesiologists (ASA) scores, concomitant diseases, neoadjuvant radiation therapy (in rectal cancer patients), tumor location, operation type, multivisceral resections, conversion rate and reason (only between the Con >70 and Con <70 groups), operation time, intraoperative bleeding, rate and amount of perioperative blood transfusion, complications, reoperations, length of hospital stay, 30-day mortality, and pathological results [differentiation, T and N stages (and number of tumor-positive lymph nodes), number of harvested lymph nodes, vascular and perineural invasion, radial margin status (for rectal cancers only), and tumor stage]. In addition, risk factors for conversion in geriatric patients were also calculated using univariate and multivariate analysis.

Statistics

Data were analyzed using SPSS 21.0 for Windows (IBM Corp, Armonk, NY). The results are presented as percentages or median and range. Quantitative and qualitative variables were compared using Mann-Whitney U test and chi-square (Pearson's or Fischer's Exact) tests,

respectively. A multivariate analysis model was established using logistic regression method and considering parameters that had a p value of <0.25 in univariate analysis. P <0.05 was considered statistically significant.

Results

There were 700 patients who were operated for CRC during the study period, and of these, 156 (22.3%) were aged >70 years. The conversion rate was 17.3% (27/156) and 9.6% (52/544) in patients aged >70 and <70 years, respectively (p=0.011).

Con >70 vs. Lap >70 group

The Con >70 group had significantly more females, but other patient-related factors and tumor locations were similar between the groups (Table 1). Considering perioperative measures in geriatric patients, the conversion significantly increased the operation time, intraoperative bleeding, necessity of blood transfusion, and the requirement of

Table 2. Operation types and intra- and peri-operative aspects

Operations	Con>70 (n=27) n (%)	Lap>70 (n=129) n (%)	p	Con<70 (n=52) n (%)	p
Operation types			0.283		0.999
Right or left colectomy or anterior resection	6 (22.2)	43 (33.3)		11 (21.2)	
Extended right or left colectomy or subtotal colectomy	9 (33.3)	24 (18.6)		17 (32.7)	
Low anterior resection	10 (37)	45 (34.9)		19 (36.5)	
Abdominoperineal resection	2 (7.4)	17 (13.2)		5 (9.6)	
Operation time, mean (range) (min) ^a	198(120-310) (n=24)	185 (60-135) (n=125)	0.046	240 (80-450) (n=48)	0.038
Intraoperative bleeding, mean (range) ^a	400 (30-1500) (n=25)	200 (10-700) (n=123)	<0.001	400 (30-1800) (n=50)	0.717
Perioperative blood transfusion, rate	20 (74.1)	53 (41.4)	0.002	32 (62.7)	0.313
Amount (U), mean (range)	3 (0-9)	0 (0-10)	<0.001	2 (0-16)	0.207
Multivisceral organ resection	9 (33.3)	15 (11.6)	0.008	24 (46.2)	0.273
Ovary	4 (14.8)	2 (0.8)	0.003	3 (5.8)	0.222
Uterus	3 (11.1)	2 (1.6)	0.037	2 (3.8)	0.331
Abdominal wall	3 (11.1)	2 (1.6)	0.037	2 (3.8)	0.331
Vagina	2 (7.4)	6 (4.7)	0.628	1 (1.9)	0.268
Small bowel	2 (7.4)	4 (3.1)	0.278	3 (5.8)	0.999
Bladder	1 (3.7)	1 (0.8)	0.317	10 (19.2)	0.087
Colon	1 (3.7)	1 (0.8)	0.317	2 (3.8)	0.999
Ureter	0	0	NA	9 (17.3)	0.024
Duodenum	0	0	NA	2 (3.8)	0.544
Stomach	0	0	NA	3 (5.8)	0.547
Spleen	0	1 (0.8)	0.999	2 (3.8)	0.544
Prostate	0	0	NA	2 (3.8)	0.544
Pancreas	0	1 (0.8)	0.999	1 (1.9)	0.999

^a Only the number of the patients shown in the parentheses were considered during the calculations because of the missed information; NA: not applicable

Table 3. Postoperative complications, reoperations, 30-day mortality and length of hospital stay

Variables	Con>70 (n=27) n (%)	Lap>70 (n=129) n (%)	p	Con<70 (n=52) n (%)	p
Surgical site infection	11 (40.7)	7 (5.4)	<0.001	6 (11.5)	0.003
Wound infection	6 (22.2)	5 (3.9)	0.004	6 (11.5)	0.321
Intra-abdominal abscess	2 (7.4)	2 (1.6)	0.139	3 (5.8)	0.999
Evisceration	5 (18.5)	2 (1.6)	<0.001	1 (1.9)	0.016
Non-surgical problems	4 (14.8)	14 (10.9)	0.519	2 (3.8)	0.173
Anastomotic leak ^a	3 (14.3) (n=21)	4 (3.7) (n=109)	0.083	5 (10.4) (n=48)	0.999
Prolonged drainage	1 (3.7)	3 (2.3)	0.536	4 (7.7)	0.656
Paralytic ileus	0	3 (2.3)	0.999	1 (1.9)	0.999
Urinary complications	0	2 (1.6)	0.999	3 (5.8)	0.547
Overall complications	14 (51.9)	29 (22.5)	0.001	17 (32.7)	0.098
Re-operation	3 (11.1)	2 (1.6)	0.037	5 (9.6)	0.999
Anastomotic leak ^a	2 (9.5) (n=21)	0 (n=109)	0.025	2 (4.2) (n=48)	0.592
Bleeding	1 (3.7)	0	0.173	2 (3.8)	0.999
Stoma prolapse	0	1 (0.8)	0.999	1 (1.9)	0.999
Missed bowel injury	0	1 (0.8)	0.999	0	NA
30-day mortality	2 (7.4)	6 (4.7)	0.628	3 (5.8)	0.999
Length of hospital stay (days)	8 (4-46)	6 (2-25)	0.002	8 (4-36)	0.287

^a Only the patients who had an anastomosis were considered during calculation;NA: not applicable

multivisceral resections, particularly involving the ovary, uterus, and abdominal wall (Table 2). Conversion worsened the postoperative results in geriatric patients, including incidence of overall complications, SSI, wound infection, evisceration, reoperation, reoperation due to anastomotic leak, and length of hospital stay (Table 3). The study also analyzed the pathological results. Tumor stage was more advanced in patients whose operation was converted and when pathologic T (pT) category, number of malignant lymph nodes, and perineural invasion rates were considered. However, the number of harvested lymph nodes was similar between the groups (Table 4).

Con >70 vs. Con <70 group

There were more females in the Con >70 group than in the Con <70 group. The overall concomitant disease frequency was higher but not significant in the Con >70 group, except the rate of hypertension (Table 1). The reasons for conversion in geriatric and younger patients were evaluated, and a comparison between groups did not reveal statistical difference. Univariate analysis showed female gender and clinical T4 tumor leading to multivisceral organ resections as significant factors for conversion in geriatric patients; however, multivariate analyses did not identify any variable as a significant factor (Table 5).

Age did not affect perioperative measures, except the operation time, which was significantly longer in younger patients (Con <70 group). This may be related to the significantly higher incidence of multivisceral resections, particularly ureteral resection in this group (Table 2). Conversion more commonly caused SSI and evisceration in geriatric patients than in younger patients (Table 3). The analyses of pathological results showed no differences between the groups (Table 4).

Discussion

In the present study, among 156 geriatric patients, the conversion rate was 17.3%, significantly higher than that in younger patients (9.6%). There have been three large-volume studies, including a national database collecting data from more than 1,500 institutions in the United States analyzing the information of 46,000 patients, National Dutch audit abstracting the information of >44,000 cases, and a review of 18 studies representing >53,000 patients. These studies have revealed a conversion rate between 5.7% and 23.5% [8,10,22]. However, all three studies have denied older age as a risk factor for conversion. Although there was a significantly higher rate of conversion in the geriatric patients in our study, the exact reason for this occurrence is unknown. In our opinion, age-related

Table 4. Pathological results of the tumors

Pathological results	Con>70 (n=27) n (%)	Lap>70 (n=129) n (%)	p	Con<70 (n=52) n (%)	p
pT Stage			0.014		0.416
0 ^a	0	3 (2.3)		1 (1.9)	
1	2 (7.4)	2 (1.6)		0	
2	2 (7.4)	27 (20.9)		4 (7.7)	
3	19 (70.4)	94 (72.9)		37 (71.2)	
4	4 (14.8)	3 (2.3)		10 (19.2)	
Differentiation			0.253		0.728
Poor	4 (14.8)	9 (7)		4 (7.7)	
Moderate	17 (63)	71 (55)		34 (65.4)	
High	4 (14.8)	39 (30.2)		11 (21.2)	
Missed	2 (7.4)	10 (7.8)		3 (5.8)	
Number of harvested lymph nodes, mean (range)	15 (5-72)	14 (0-74)	0.884	21 (1-102)	0.081
Number of malignant lymph nodes, mean (range)	0 (0-21)	0 (0-15)	0.036	0.5 (0-29)	0.872
pN stage			0.126		0.776
0	14 (51.9)	87 (67.4)		26 (50)	
1	7 (25.9)	30 (23.3)		17 (32.7)	
2	6 (22.2)	12 (9.3)		9 (17.3)	
Vascular invasion	11 (40.7)	34 (26.6)	0.140	19 (36.5)	0.715
Perineural invasion	17 (63)	31 (24.2)	<0.001	23 (44.2)	0.114
Positive radial margin	1 (3.7)	1 (0.8)	0.317	4 (7.7)	0.656
Tumor stage			0.081		0.489
0	0	2 (1.6)		1 (1.9)	
1	3 (11.1)	24 (18.6)		3 (5.8)	
2	9 (33.3)	58 (45)		21 (40.4)	
3	10 (37)	40 (31)		23 (44.2)	
4	5 (18.5)	5 (3.9)		4 (7.7)	

^a T0 includes patients who had complete response after preoperative radiation therapy

Table 5. Reasons for conversion in Con>70 and Con<70 groups

Conversions	Con>70 (n=27) n (%)	Con<70 (n=52) n (%)	p
Clinical T4 tumor	8(29.6)	25 (48.1)	0.115
Limited exploration due to dilated bowel segments	3 (11.1)	6 (11.5)	0.999
Technical problems	3 (11.1)	5 (9.6)	0.999
Hemorrhage	3 (11.1)	2 (3.8)	0.331
Insufficient anatomic identification	2 (7.4)	7 (13.5)	0.711
Colon perforation	2 (7.4)	4 (7.7)	0.999
Organ injury	2 (7.4)	1 (1.9)	0.268
Hepatic metastasis diagnosed during exploration	2 (7.4)	0	0.114
Severe intra-abdominal adhesions	1 (3.7)	0	0.999
Medical	1 (3.7)	0	0.342
Close surgical margin	0	1 (1.9)	0.999
	Univariate p	Multivariate p	Odds Ratio (95% CI)
Gender (female)	0.017	0.136	0.481 (0.184-1.260)
Any concomitant disease	0.052	0.131	0.492 (0.196-1.236)
Clinical T4 tumor leading to multivisceral organ resections	0.008	0.057	0.349 (0.118-1.034)
Node positivity	0.123	0.334	0.642 (0.262-1.577)

comorbidities had a negligible impact on conversion because there was only one case that required conversion for intraoperative medical problems in this group. When risk factors for conversion were analyzed, the present study showed that clinical T4 tumors necessitating multivisceral resections were the most common reason for conversion in geriatric patients. A recent meta-analysis and several other studies have noted locally advanced tumors as a significant factor for conversion, which is required to achieve an oncologically safe *en bloc* resection [23-26]. Another surprising finding in the present study was the significantly higher incidence of conversion in geriatric female patients. Several studies have revealed male gender as a risk factor for conversion, particularly in cases of rectal cancer [8,10,19,27,28]. Alternatively, a previous study from our institution evaluating risk factors for multivisceral resections for T4 tumors revealed that females had a higher risk for locally advanced tumors than males (33 vs. 20%) [29]. The present study also showed that resection rates of gynecological organs, including the ovary and uterus, are significantly higher in converted patients as a part of multivisceral resections to achieve an oncologically safe procedure. Thus, we believe that the higher incidence of conversion in females in the present study was most likely related to the higher requirement of multiple organ resections in geriatric patients than in younger patients, particularly the higher incidence of gynecological organ removal. The present study also examined several factors for their impact on conversion using univariate and multivariate analyses. Although univariate analyses revealed that clinical T4 tumors leading to multivisceral resections and female gender were significant risk factors, multivariate analyses did not define any risk factor for conversion. The lack of statistical significance in multivariate analysis in the present study may be because there were only 27 and 52 patients in the Con >70 and Con <70 groups, respectively.

The present data have highlighted that intraoperative bleeding and the rate and amount of perioperative transfusion have increased, and the operation time has been prolonged in converted geriatric patients than in laparoscopic cases. These results are correlated with previously published information, which did not separately analyze outcomes of conversion in geriatric patients [12,29]. Furthermore, at least two pooled analyses have shown that converted patients were more likely to require blood transfusion [10,19].

The present study has revealed that the previously reported adverse consequences of conversion

were probably more accurate for geriatric patients who required conversion. SSI, particularly wound infection and evisceration, was significantly increased in geriatric patients who required conversion. Similarly, the requirement of a reoperation showed a statistically significant increase of up to 11.1% after conversion compared with cases that did not require conversion. Furthermore, two of our three converted cases with an anastomotic leak required a reoperation, whereas none of the four cases that did not require conversion were successfully treated with a non-operative approach. In addition, the present data showed that the operation time was shorter in geriatric patients than in younger ones who underwent conversion, which was most likely because clinical T4 tumors and related multivisceral resections were more prevalent (but not significantly more) in the Con <70 group. Thus, conversion may lead to some deteriorated perioperative outcomes in geriatric patients than in younger patients, and these worse results may be linked to consequences of conversion other than older age because the comparison of these parameters in younger and geriatric patients demonstrated similar results.

Several studies have reported that conversion increased the overall complication rate, particularly the incidence of SSI [9-11,13,22,29,30]. Because conversion necessitated a longer incision, the adverse consequences of conversion on the risks of wound infection and evisceration have also been well defined [10,12,13]. Moreover, the present study is the first to show that these adverse consequences of conversion may be more commonly observed in adults aged >70 years maybe because age also has a negative impact on wound healing, as has been recently reported in a meta-analysis evaluating the outcomes of laparoscopic CRC in geriatric patients [20]. Previous data have presented a reoperation rate up to 15% in converted patients, and the present study has shown a significantly higher reoperation rate after conversion, mostly for the treatment of anastomotic leak [13]. In contrast, it is necessary to emphasize that this conclusion is dependent on results of very few patients; thus, it should be interpreted accordingly. As expected, increased morbidity leads to a longer hospital stay, and present findings have revealed that this is also true for geriatric patients.

Finally, the present study evaluated the pathological results of tumors. Multivisceral resections for clinical T4 tumors were a notable factor for conversion, and the incidence of pT4 tumors was also higher in converted patients, confirming the possibility that these patients had more advanced tumors. Two other variables supported this finding

because the number of malignant lymph nodes and rate of perineural invasion were significantly higher in the Con >70 group than in the Lap >70 group. The most important part of the present study is the one evaluating the impact of conversion on the surgical quality. Further comparisons have shown that the number of harvested lymph nodes and positivity of radial margin were similar in converted and laparoscopic cases. This is a key finding showing that principles of oncological surgery are also followed in patients who are converted and conversion does not lead to an impairment in the surgical quality.

The present study has some limitations. The most significant limitation is the retrospective nature of the study, although the database has a prospective design. In addition, the number of patients in the study was restricted because a highly specific issue was being studied. This limitation may be the reason for statistically insignificant results comparing some outcomes, particularly the multivariate analysis of risk factors for conversion. Another important point is that the study period was almost 12 years, and all procedures were performed or supervised by a single surgeon. Thus, increased years of experience resulted in improved operative technique and enhanced perioperative recovery practices that may have impacted the outcomes. This has not been considered in the present study. In our opinion, this is an important issue that should be carefully considered while analyzing the outcomes and conclusions.

Conclusions

This retrospective study evaluating the incidence, risk factors, and outcomes of conversion in geriatric patients has some significant findings, some of which have not been previously examined. The present study revealed that the conversion rate is significantly higher in geriatric patients than in younger patients, particularly in females, and those who require multivisceral resections for T4 tumors, although multivariate analysis failed to reveal a significant risk factor for conversion. In addition, conversion in geriatric patients worsened the perioperative outcomes, including operation time, requirement for multivisceral resections, intraoperative bleeding, and the necessity for transfusion. Conversion also increased the risks of complications, including SSI, wound infection, and evisceration, and the possibility of a reoperation. These patients seemed to have more advanced tumors. However, the oncological surgery quality probably did not deteriorate with conversion because the number of harvested lymph nodes did not decrease in converted patients. Comparing geriatric and younger converted patients revealed that risk factors and outcomes of conversion were similar, except for an increased risk of SSI and evisceration in geriatric patients and longer operation time in younger patients.

Conflict of interests

The authors declare no conflict of interests.

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