Short- and Long-term Outcomes After Laparoscopic Emergency Resection of Left-Sided Obstructive Colon Cancer

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Published in:
Diseases of the Colon and Rectum

DOI:
10.1097/DCR.0000000000002364

ORIGINAL CONTRIBUTION

Short- and Long-term Outcomes After Laparoscopic Emergency Resection of Left-Sided Obstructive Colon Cancer: A Nationwide Propensity Score–Matched Analysis

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BACKGROUND: The role of laparoscopy for emergency resection of left-sided obstructive colon cancer remains unclear, especially regarding impact on survival.

OBJECTIVE: This study aimed to determine short- and long-term outcomes after laparoscopic versus open emergency resection of left-sided obstructive colon cancer.

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Funding/Support: This study received a grant from the Dutch Cancer Society (KWF) and Citrienfonds.

Financial Disclosure: None reported.

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Dis Colon Rectum 2023; 66: 774–784
DOI: 10.1097/DCR.0000000000002364

DESIGN: This observational cohort study compared patients who underwent laparoscopic emergency resection to those who underwent open emergency resection between 2009 and 2016 by using 1:3 propensity-score matching. Matching variables included sex, age, BMI, ASA score, previous abdominal surgery, tumor location, cT4, cM1, multivisceral resection, small-bowel distention on CT, and subtotal colectomy.

SETTING: This was a nationwide, population-based study.

PATIENTS: Of 2002 eligible patients with left-sided obstructive colon cancer, 158 patients who underwent laparoscopic emergency resection were matched with 474 patients who underwent open emergency resection.

INTERVENTIONS: The intervention was laparoscopic versus open emergency resection.

MAIN OUTCOME MEASURES: The main outcome measures were 90-day mortality, 90-day complications, permanent stoma, disease recurrence, overall survival, and disease-free survival.

RESULTS: Intentional laparoscopy resulted in significantly fewer 90-day complications (26.6% vs 38.4%; conditional OR, 0.59; 95% CI, 0.39–0.87) and similar 90-day mortality. Laparoscopy resulted in better 3-year overall survival (81.0% vs 69.4%; HR, 0.54; 95% CI, 0.37–0.79) and disease-free survival (68.3% vs 52.3%; HR, 0.64; 95% CI, 0.47–0.87). Multivariable regression analyses of the unmatched 2002 patients confirmed an independent association of laparoscopy with fewer 90-day complications and better 3-year survival.

LIMITATIONS: Selection bias was the limitation that cannot be completely ruled out because of the retrospective nature of this study.

CONCLUSIONS: This population-based study with propensity score–matched analysis suggests that intentional laparoscopic emergency resection might improve outcomes in patients with left-sided obstructive colon cancer compared to open emergency resection. Management of those patients in the emergency setting requires proper selection for intentional laparoscopic resection if relevant expertise is available, thereby considering other alternatives to avoid open emergency resection (ie, decompressing stoma). See **Video Abstract** at http://links.lww.com/DCR/B972.

RESULTADOS A CORTO Y LARGO PLAZO DESPUÉS DE LA RESECCIÓN LAPAROSCÓPICA DE EMERGENCIA EN CÁNCER DE COLON IZQUIERDO OBSTRUCTIVO: UN ANÁLISIS EMPAREJADO POR PUNTAJE DE PROPENSIÓN A NIVEL NACIONAL

ANTECEDENTES: El papel de la laparoscopia en la resección de emergencia en cáncer de colon izquierdo obstructivo sigue sin estar claro, especialmente con respecto al impacto en la supervivencia.

OBJETIVO: El objetivo de este estudio fue determinar los resultados a corto y largo plazo después de la resección de emergencia laparoscópica versus abierta en cáncer de colon izquierdo obstructivo.

DISEÑO: Estudio observacional de cohortes comparó pacientes que se sometieron a resección de laparoscópica de emergencia versus resección abierta de emergencia entre 2009 y 2016, mediante el uso de emparejamineto por puntaje de propensión 1: 3. Las variables emparejadas incluyeron sexo, edad, IMC, puntaje ASA, cirugía abdominal previa, ubicación del tumor, cT4, cM1, resección multivisceral, distensión del intestino delgado en la TAC y colectomía subtotal.

ENTORNO CLINICO: A nivel nacional, basado en la población.

PACIENTES: De 2002 pacientes elegibles con cáncer de colon izquierdo obstructivo, 158 pacientes con resección laparoscópica s de emergencia e emparejaron con 474 pacientes con resección abierta de emergencia.

INTERVENCIONES: Resección laparoscópica de emergencia versus abierta.

PRINCIPALES MEDIDAS DE RESULTADO: Las medidas primarias fueron la mortalidad a 90 días, complicaciones a 90 días, estoma permanente, recurrencia de la enfermedad, supervivencia general y supervivencia libre de enfermedad.

RESULTADOS: La laparoscopia intencional dió como resultado significativamente menos complicaciones a los 90 días (26,6 % vs 38,4 %, cOR 0,59, IC del 95 %: 0,39-0,87) y una mortalidad similar a los 90 días. La laparoscopia resultó en una mejor supervivencia general a los 3 años (81,0 % vs 69,4 %, HR 0,54, IC del 95 % 0,37-0,79) y supervivencia libre de enfermedad (68,3 % vs 52,3 %, HR 0,64, IC del 95 % 0,47-0,87). Los análisis de regresión multivariable de los 2002 pacientes no emparejados confirmaron una asociación independiente de la laparoscopia con menos complicaciones a los 90 días y una mejor supervivencia a los 3 años.

LIMITACIONES: El sesgo de selección no se puede descartar por completo debido a la naturaleza retrospectiva de este estudio.

CONCLUSIONES: Estudio poblacional con análisis emparejado por puntaje de propensión sugiere que la resección laparoscópica de emergencia intencional podría mejorar los resultados a corto y largo plazo en pacientes con cáncer de colon izquierdo obstructivo en comparación con resección abierta de emergencia, lo que justifica la confirmación en estudios futuros. El manejo de esos pacientes en el entorno de emergencia requiere una selección adecuada para la resección laparoscópica intencional si se dispone de experiencia relevante, considerando así otras alternativas para evitar la resección abierta de emergencia (es decir, ostomia descompresiva). Consulte **Video Resumen** en http://links.lww.com/DCR/B972. *(Traducción— Dr. Francisco M. Abarca-Rendon* & Dr. Fidel Ruiz Healy)

KEY WORDS: Emergency resection; Laparoscopy; Left-sided obstructive colon cancer; Oncological outcomes; Open surgery.

Treatment of left-sided obstructive colon cancer (LSOCC) is challenging, and surgical treatment in the emergency setting is associated with high postoperative morbidity and mortality.[1] To improve patient and surgical conditions preoperatively, a bridge-to-surgery approach with either a self-extendable metal stent or decompressing stoma (DS) can be chosen. However, emergency resection is still a valuable option for selected patients.[2] Evaluation of clinical practice in the Netherlands has even shown that emergency resection was the most frequently used treatment between 2009 and 2016, with approximately 90% of emergency resections performed by laparotomy.[3]

Laparoscopy has been implemented as the standard surgical approach for colon cancer in the elective setting in many institutions worldwide over the past 2 decades. In this setting, laparoscopic treatment provides improved postoperative outcomes, mainly explained by less surgical trauma and faster recovery.[4] In addition, laparoscopy showed at least equal long-term oncological outcomes in multiple randomized controlled trials,[5] whereas some more recent population-based studies even suggest a survival benefit.[6,7] Hence, we hypothesized that the advantages of laparoscopy might be even more pronounced in the emergency setting because these patients are at the highest risk of postoperative morbidity and mortality.

There are various previously conducted observational studies that compared postoperative outcomes after open and laparoscopic colon cancer surgery in the emergency setting.[8–12] However, little evidence exists on emergency laparoscopic resection of LSOCC specifically, and none were able to sufficiently investigate long-term outcomes. Therefore, we sought to investigate the role of laparoscopic versus open emergency resection of LSOCC with regard to short-term and long-term outcomes in a population-based cohort by using propensity score matching.

MATERIALS AND METHODS

Registry

This retrospective comparative cohort study used short- and long-term data collected by a national collaborative research project initiated by the Dutch Snapshot Research Group. The methodology and other details of this project have been described previously.[13] In short, patients who underwent resection for primary LSOCC in the Netherlands between 2009 and 2016 were identified using the Dutch Colorectal Audit database. This is a national database for which all Dutch hospitals mandatorily collect patient and procedural characteristics and postoperative outcomes for up to 30 days. To complement and extend these data, all 77 Dutch hospitals were asked to provide additional procedural characteristics and long-term data by using a secured web-based tool. Data were retrieved from original patient files and entered into the tool by surgical residents under supervision of 1 or 2 consultant surgeons. After a period of data verification, data were eventually anonymized. Given the observational design of this study, the Medical Ethics Committee of the Amsterdam University Medical Centers decided that informed consent was not warranted. We designed this study and prepared the article in accordance with the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) statement.[14]

Patient Cohort

Patients were included if they had symptomatic colonic obstruction (ie, nausea, vomiting, obstipation, and/or abdominal distention) and radiological imaging showing dilation of the colon proximal to the primary tumor with or without a dilated small bowel. Patients were included who had a confirmed diagnosis of malignancy by histopathological assessment and had to be treated with an emergency resection. Patients who had documented bowel perforation or signs of free air on preoperative CT scan, a prior bridge-to-surgery procedure (ie, DS or self-extendable metal stent), and treatment with palliative intent.

End Points

The primary end point was the total 90-day resection-related complication rate. Secondary end points were short-term outcomes: 90-day mortality, anastomotic leakage, intra-abdominal abscess, fascial dehiscence, surgical site infection, ileus, gastroparesis, bleeding, abdominal wall abscess, length of stay in days, and time until initiation of adjuvant chemotherapy in weeks. Long-term outcomes included overall complications during the entire follow-up, readmissions, reinterventions, intraperitoneal recurrence, distant metastases, permanent stoma rate, and 3-year overall and disease-free survival. Reinterventions entailed surgical, endoscopic, or radiological reinterventions that were attributable to complications. Intraperitoneal recurrence included either local recurrence at the side of the anastomosis, regional lymph metastases, or peritoneal metastases.

Statistical Analysis

When appropriate, we presented categorical variables as numbers and percentages and continuous variables as means with SDs or as medians with interquartile ranges when appropriate. Propensity score matching was used to adjust treatment allocation and restrict our analysis to the most optimally balanced patient group beforehand. We selected preoperative covariates to match patients, which in our opinion could have affected the choice of treatment approach, including sex, age, BMI, ASA score, previous abdominal surgery, tumor location (ie, splenic flexure, descending colon, or sigmoid), preoperative clinical T and M stage, multivisceral resection, small-bowel distention on CT, and subtotal colectomy. Subtotal colectomy was considered to be representative of the severity of colonic distention. We imputed missing data for the selected covariates by chained equations (MICE package in R software) before calculating the propensity score. Covariates with more than 20% missing values were excluded from further analysis. Subsequently, we performed 1 to 3 nearest neighbor matching without replacement with a caliper of 0.2 logit of the SD of the propensity score (optimal matching).[15] We assessed covariate balance before and after matching with standardized mean differences (SMDs). SMDs of less than 10% represented a negligible difference in outcomes between the 2 groups.[16] To account for the paired nature of data, differences in outcomes in the matched cohort were assessed with conditional logistic regression. Conditional ORs (cORs) with 95% CIs were calculated. Regarding survival analyses, Kaplan-Meier curves were plotted and survival probabilities were compared using Cox proportional hazards regression with shared frailty analysis, with open surgery as the reference.[17] Shared frailty analysis can be used to model survival outcomes in clustered data by propensity score matching. In the original, unmatched cohort, additional analyses were performed to substantiate the findings regarding the primary end point and overall survival outcome and to adjust for differences found in intraoperative and postoperative characteristics in the matched cohort after propensity score matching. Multivariable logistic regression and Cox regression survival analyses were used, selecting covariates according to the enter method. Differences with a p value of <0.05 were considered to be statistically significant. Analyses were performed according to the intention-to-treat principle, meaning that converted laparoscopic procedures were analyzed within the laparoscopy group. Analyses were performed using IBM SPSS statistics version 25.0 (IBM Corp) and R software version R3.3.2 (Matching and Frailtypack packages, R Foundation for Statistical Computing).

RESULTS

Baseline Characteristics

The patient selection procedure is presented in Figure 1. Of the 77 hospitals in the Netherlands, 75 participated in this study, resulting in the registration of 3879 patients. After applying the inclusion and exclusion criteria, 2002 patients with LSOCC who underwent emergency resection were eligible for the present analyses, of whom 1843 patients (92.1%) underwent open surgery and 159 patients (7.9%) underwent laparoscopic surgery. The 1:3 propensity score matching resulted in a final matched cohort of 632 patients, of whom 474 patients (75%) underwent open surgery and 158 patients (25%) underwent laparoscopic

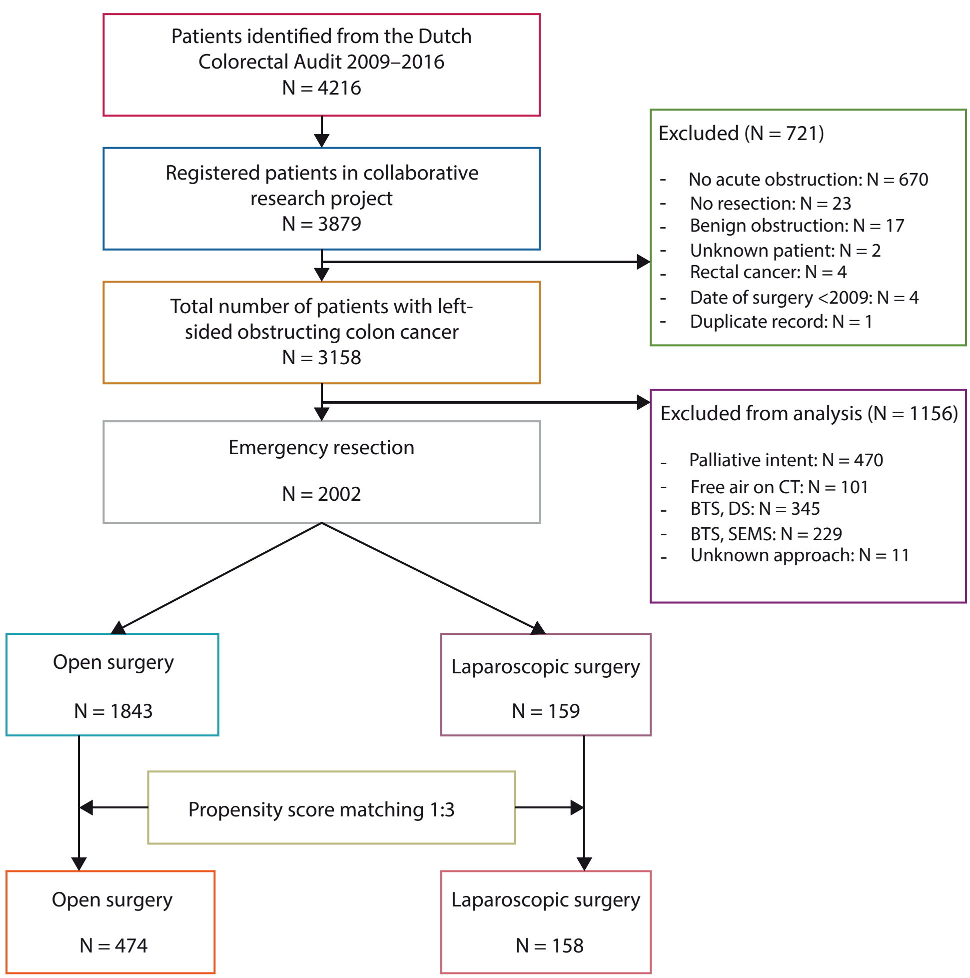


FIGURE 1. Flow chart of patient selection. BTS = bridge to surgery; DS = decompressing stoma; SEMS = self-extendable metal stent.

TABLE 1. Baseline characteristics with SMDs before and after 1:3 propensity score matching

	Before propensity score matching				*After propensity score matching*			
	Missing	*Laparoscopy (N = 159)*	*Open (N = 1843)*	*SMD*	*Missing*	*Laparoscopy (N = 158)*	*Open (N = 474)*	*SMD*
Characteristics	*%*	*n (%)*	*n (%)*	*%*	*%*	*n (%)*	*n (%)*	*%*
Sex, female	0	65 (40.9)	873 (47.4)	−13.16	0	65 (41.1)	192 (40.5)	1.28
Age, y, mean (SD)	0	68.8 (11.9)	70.2 (11.8)	−11.28	0	69.1 (11.6)	69.0 (11.3)	0.47
BMI, mean (SD)	17.9	25.7 (3.9)	25.4 (4.2)	6.17	0	25.6 (4.1)	25.4 (4.2)	6.42
ASA score ≥3	0.9	51 (32.5)	630 (34.5)	−4.85	0	51 (32.3)	159 (33.5)	−2.69
Previous abdominal surgery	0.9	40 (25.3)	551 (30.2)	−11.87	0	40 (25.3)	125 (26.4)	−2.42
Tumor location								
Splenic flexure	0	19 (11.9)	254 (13.8)	−5.63	0	19 (12.0)	59 (12.4)	−1.29
Descending colon		24 (15.1)	350 (19.0)	−10.85		24 (15.2)	61 (12.9)	6.44
Sigmoid		116 (73.0)	1239 (67.2)	12.85		115 (72.8)	354 (74.7)	−4.25
cT4 stage	0	9 (5.7)	57 (3.1)	11.07	0	9 (5.7)	20 (4.2)	6.35
cM1 stage	2.7	10 (6.5)	169 (9.4)	−12.72	0	10 (6.3)	26 (5.5)	3.45
Multivisceral resection	1.9	10 (6.5)	155 (8.6)	−9.15	0	10 (6.3)	30 (6.3)	0
Small-bowel distention on CT	20.6	59 (50.0)	1035 (70.3)	−35.73	0	83 (52.5)	241 (50.8)	3.37
Subtotal colectomy	0	4 (2.5)	153 (8.3)	−36.83	0	4 (2.5)	16 (3.4)	−5.35

cM1 = preoperative metastases present; cT4 = preoperative T4; SMD = standardized mean difference.

surgery. Baseline characteristics of the original and matched cohort are presented in Table 1 along with the balance of the covariate distribution in the cohorts before and after matching, expressed as SMDs. After matching, the SMDs of all covariates were less than 10%.

Clinical, Surgical, and Tumor Characteristics

Clinical parameters, surgical characteristics, and histopathological outcomes, stratified by treatment approach, are presented in Table 2. Relevant blood tests at the time of presentation, such as C-reactive protein (CRP), leukocytes, and creatinine, were comparable in both groups. Preoperative cecal diameter on CT was missing in 57.1%; based on evaluable patients, median cecal diameter was smaller in the laparoscopy group (median 7.0 vs 8.6; $p = 0.02$). Fifty laparoscopic procedures were converted (34.4%), of which 42 were early conversions. Accessibility was documented as the main reason for early conversion in 31 patients (73.8%). A primary anastomosis was created more often in laparoscopically treated patients (57.0% vs 39.5%; $p < 0.001$), and fewer stomas were constructed (48.1% vs 66.2%; $p < 0.001$). We found no significant differences in tumor stage or in R0 resections between the 2 groups.

Short-term Outcomes

As shown in Table 3, the total 90-day resection-related complication rate was significantly lower in patients who underwent an intentional emergency laparoscopic resection in comparison with those treated by open resection (26.6% vs 38.4%; cOR, 0.59; 95% CI, 0.39–0.87). Surgical site infections and ileus were less likely to occur in patients treated by laparoscopy compared to patients who underwent open surgery (surgical site infection: 5.8% vs 12.5%; $p = 0.02$ and ileus: 5.2% vs 11.7%; $p = 0.03$). Ninety-day mortality was similar in both groups. Patients in the laparoscopy group had a shorter median length of hospital stay (8 vs 11 d). The proportion of patients receiving adjuvant chemotherapy was similar in both groups, along with time to initiation of adjuvant chemotherapy. Additional analysis of the unmatched cohort showed that nonconverted laparoscopy was independently associated with fewer 90-day resection-related complications (OR, 0.29; 95% CI, 0.16–0.57; see Supplemental Table 1 at http://links.lww.com/DCR/B971) when adjusted for age, sex, ASA score, procedure type, stoma creation, CRP, and small-bowel distention on CT.

Long-term Outcomes

Outcomes of the entire follow-up, with a median length of follow-up of 34 months in the laparoscopy group and 30 months in the open surgery group, are presented in Table 4. The overall complication rate was lower in laparoscopy-treated patients compared with patients who underwent open surgery (34.8% vs 48.7%; cOR, 0.57; 95% CI, 0.39–0.82). Readmissions and reinterventions were not significantly different. The permanent stoma rate was lower in the laparoscopy group compared to the open surgery group (31.4% vs 43.6%; $p = 0.006$), although this difference was not observed in patients with at least 12 months of follow-up. Three-year overall survival was higher after emergency laparoscopic resection than after open surgery (81.0% vs 69.4%; with frailty analysis HR, 0.54; 95% CI, 0.37–0.79; Fig. 2), and 3-year disease-free survival was also higher (68.3% vs 52.3%; with frailty analysis HR, 0.64; 95% CI, 0.47–0.87; Fig. 3). Intraperitoneal recurrence and distant

TABLE 2. Clinical features, procedural characteristics, and histopathological characteristics in the matched cohort (n = 632)

Characteristics	*Missing, %*	*Laparoscopy (N = 158), n (%)*	*Open (N = 474), n (%)*	*cOR (95% CI)*	*p*
Clinical feature					
C-reactive protein, (median, IQR)	10.4	15.0 (0–42.0)	14.0 (0–42.8)	0.99 (0.99–1.03)	0.52
<10 (mg/L)		51 (36.2)	156 (36.7)	0.96 (0.65–1.43)	0.84
10–50 (mg/L)		66 (46.8)	192 (45.2)	1.12 (0.75–1.67)	0.59
>50 (mg/L)		24 (17.0)	77 (18.1)	0.88 0.51–1.52)	0.65
Leukocytes (10^9/L), median (IQR)	8.7	10.4 (5.4–15.4)	10.7 (5.6–15.8)	0.99 (0.96–1.04)	0.88
Creatinine, median (IQR)	11.4	79.0 (50.0–108.0)	79.0 (45–113)	0.99 (0.99–1.00)	0.17
<110 (μmol/L)		128 (89.5)	348 (83.5)	1.67 (0.90–3.07)	0.10
110–200 (μmol/L)		15 (10.5)	60 (14.4)	0.72 (0.38–1.35)	0.30
>200 (μmol/L)		0 (0)	9 (2.2)	0.03 (0.0–17.48)	0.28
Cecal diameter on CT, median (IQR)	57.1	7.0 (4.3–9.7)	8.6 (6.1–10.1)	0.77 (0.61–0.96)	**0.02**
Surgical procedure					
Type of surgical procedure					
SR	0	113 (71.5)	333 (70.3)	0.85 (0.67–1.08)	0.19
LHC		40 (25.3)	115 (24.3)		
STC		4 (2.5)	16 (3.4)		
Extended LHC		1 (0.6)	2 (0.4)		
SR with RHC		0 (0)	3 (0.6)		
TR		0 (0)	5 (1.1)		
Multivisceral resection	0	10 (6.3)	30 (6.3)	1.0 (0.69–1.45)	1.0
Converted laparoscopy	8.2	50 (34.4)	–	–	–
Early		42	–		
Late		8	–		
Primary anastomosis	0.5	90 (57.0)	186 (39.5)	2.1 (1.42–3.00)	**<0.001**
Stoma constructed during resection	2.1	74 (48.1)	308 (66.2)	0.46 (0.32–0.68)	**<0.001**
Type of stoma in situ after resection					
Diverting ileostomy	2.2	9 (12.1)	32 (10.3)	1.99 (0.74–4.84)	0.18
End ileostomy		3 (4.1)	10 (3.2)		
Diverting colostomy		3 (4.1)	11 (3.6)		
End colostomy		59 (79.7)	240 (77.9)		
Time from presentation till OR ≤1	1.1	53 (33.8)	259 (55.3)	2.36 (1.62–3.43)	**<0.001**
Histopathology					
Tumor histopathology					
Adenocarcinoma	1.1	150 (95.5)	446 (95.3)	1.09 (0.54–2.21)	0.81
Mucinous carcinoma		5 (3.2)	20 (4.3)		
Signet ring cell carcinoma		2 (1.3)	2 (0.4)		
Completeness of resection					
R0	1.3	153 (97.5)	457 (97.9)	1.02 (0.43–2.41)	0.97
R1		3 (1.9)	7 (1.5)		
R2		1 (0.6)	3 (0.6)		
Angioinvasion					
None	5.4	112 (71.8)	310 (65.8)	0.93 (0.83–1.04)	0.20
Extramural venous invasion		30 (19.2)	115 (24.4)		
Lymphatic invasion		10 (6.4)	19 (4.0)		
Intramural venous invasion		0 (0)	2 (0)		
pT stage					
pT1	0.3	2 (1.3)	1 (0.2)	0.89 (0.63–1.26)	0.52
pT2		5 (3.2)	17 (3.6)		
pT3		111 (70.3)	328 (69.5)		
pT4		40 (25.3)	126 (26.7)		
pN stage					
pN0	0.3	76 (48.1)	202 (42.8)	0.84 (0.65–1.07)	0.16
pN1		58 (36.7)	178 (37.7)		
pN2		24 (15.2)	92 (19.5)		
No. of harvested lymph nodes <12	0	44 (27.8)	164 (34.6)	1.36 (0.92–2.02)	0.12

Data presented as n (%) unless otherwise indicated. Boldface indicates statistically significant findings at $p < 0.05$.
cOR = conditional OR; IQR = interquartile range; LHC = left hemicolectomy; OR = operating room; pN = N status on histopathological assessment; pT = T status on histopathological assessment; R = resection margin; RHC = right hemicolectomy; SR = sigmoid resection; STC = subtotal colectomy; TR = transverse colon resection.

metastases rates were not significantly different. Additional Cox regression analysis of the unmatched cohort with 2002 patients demonstrated that nonconverted laparoscopy was independently associated with better overall survival (HR,

TABLE 3. Resection-related short-term outcomes up to 90 d in the matched cohort (n = 632)

Outcome	*Missing, %*	*Laparoscopy (N = 158), n (%)*	*Open (N = 474), n (%)*	*cOR (95% CI)*	*p*
Mortality	0	8 (5.1)	34 (7.2)	0.70 (0.32–1.53)	0.37
Total resection-related complication rate[a]	1.9	42 (26.6)	178 (38.4)	0.59 (0.39–0.87)	**0.009**
Anastomotic leakage	0	13 (14.4)	31 (16.7)	0.88 (0.37–2.10)	0.77
Intra-abdominal abscess	0.3	9 (5.7)	31 (6.6)	0.87 (0.41–1.84)	0.71
Fascial dehiscence	6.3	2 (1.3)	22 (5.0)	0.25 (0.06–1.08)	0.06
Surgical site infection	4.4	9 (5.8)	56 (12.5)	0.43 (0.21–0.89)	**0.02**
Ileus	5.7	8 (5.2)	52 (11.7)	0.42 (0.19–0.90)	**0.03**
Gastroparesis	6.5	3 (2.0)	18 (4.1)	0.54 (0.16–1.84)	0.32
Bleeding	5.7	4 (2.6)	7 (1.6)	1.23 (0.32–4.78)	0.76
Abdominal wall abscess	7.1	0 (0)	9 (2.0)	0.03 (0.0–11.74)	0.24
Length of stay, d, median (IQR)	5.2	8 (0–16)	11 (2–20)	0.98 (0.96–0.99)	**0.04**
Adjuvant chemotherapy	1.7	69 (44.2)	191 (41.1)	1.16 (0.80–1.67)	0.44
Initiation within 8 wk	15.5	39 (28.9)	112 (28.1)	1.23 (0.88–1.75)	0.22
Initiation between 8 and 12 wk		9 (6.7)	13 (3.3)		

Data presented as n (%) unless otherwise indicated. Boldface indicates statistically significant findings at $p < 0.05$.
cOR = conditional OR; IQR = interquartile range.
[a]The total resection-related complication rate is the total number of patients in each group with a complication within 90 d postoperatively and therefore do not sum to the group total.

0.39; 95% CI, 0.21–0.73; see Supplemental Table 2 at http://links.lww.com/DCR/B971) when adjusted for age, ASA score, pT stage, pN stage, metastases at presentation, postoperative complication and reintervention, and timing of adjuvant chemotherapy.

DISCUSSION

In this population-based propensity score–matched cohort study, we compared 158 patients who underwent intentional laparoscopic emergency resection of LSOCC with 472 patients undergoing open emergency resection and found fewer 90-day resection-related complications and better overall survival and disease-free survival after intentional laparoscopic surgery. These findings were confirmed in multivariable Cox regression models of all 2002 eligible patients before matching. In addition, we found that patients who underwent an intentional laparoscopy had a shorter length of hospital stay and fewer permanent stomas. There is a risk of residual bias, but this is the best available evidence up until now.

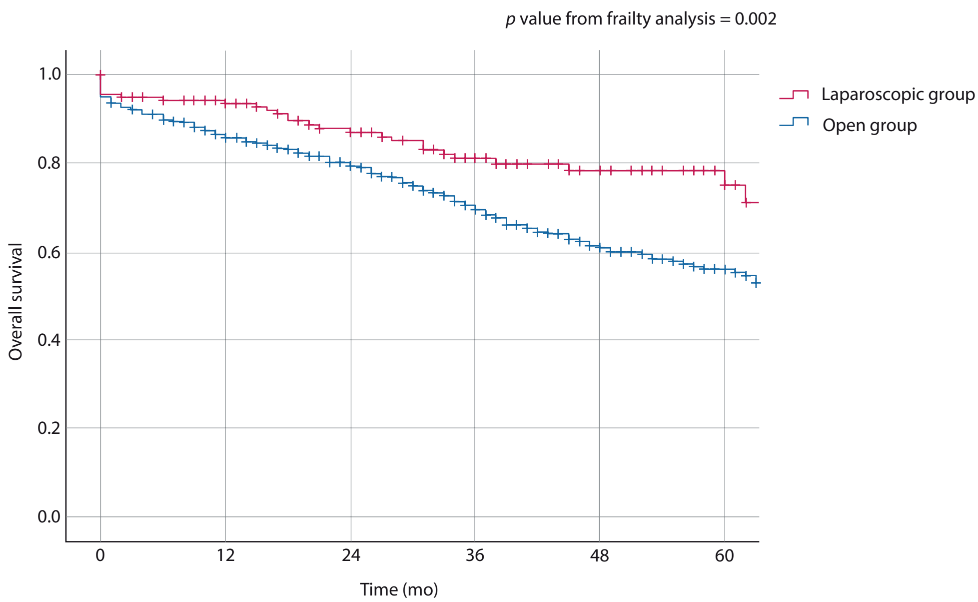
A previously published study in 2015 also investigated both short-term and long-term outcomes after laparoscopic and open emergency resection of LSOCC.[10] The authors found no difference in postoperative complications and survival. However, the authors performed no correction for possible confounders and only 55 patients were included in the laparoscopy group.

With regard to postoperative outcomes, benefits of laparoscopy for emergency resection of colon cancer

TABLE 4. Long-term outcomes of the entire follow-up in the matched cohort (n = 632)

Outcome	*Missing, %*	*Laparoscopy (N = 156), n (%)*	*Open (N = 468), n (%)*	*cOR (95% CI)*	*p*
Overall complication rate	1.6	55 (34.8)	226 (48.7)	0.57 (0.39–0.82)	**0.003**
Readmissions	0.3	22 (13.9)	88 (18.6)	0.72 (0.43–1.18)	0.19
Reinterventions	0.3	34 (21.5)	139 (29.4)	0.65 (0.42–1.00)	**0.05**
Intraperitoneal recurrence	5.5	17 (12.1)	67 (14.3)	0.82 (0.46–1.44)	0.49
Local recurrence		6 (4.1)	16 (3.6)		
Regional lymph node metastases		2 (1.4)	6 (1.3)		
Metachronous peritoneal metastases		7 (4.7)	41 (9.2)		
Unclear origin		2 (1.4)	4 (0.9)		
Distant metastases	6.5	24 (15.7)	106 (23.5)	0.64 (0.39–1.03)	0.07
Permanent stoma rate	2.1	49 (31.4)	202 (43.6)	0.57 (0.38–0.85)	**0.006**
Permanent stoma rate (>12 mo alive)	1.0	36 (29.0)	130 (36.8)	0.67 (0.41–1.09)	0.11
3-y disease-free survival, %	0.8	68.3	52.3		**0.004**
No. of events at 36 mo		42	195		
No. of patients at 36 mo		63	158		
3-y overall survival, %	0.8	81.0	69.4		**0.002**
No. of events at 36 mo		24	121		
No. of patients at 36 mo		79	198		

Data presented as n (%) unless otherwise indicated. Boldface indicates statistically significant findings at $p < 0.05$.
cOR = conditional OR.



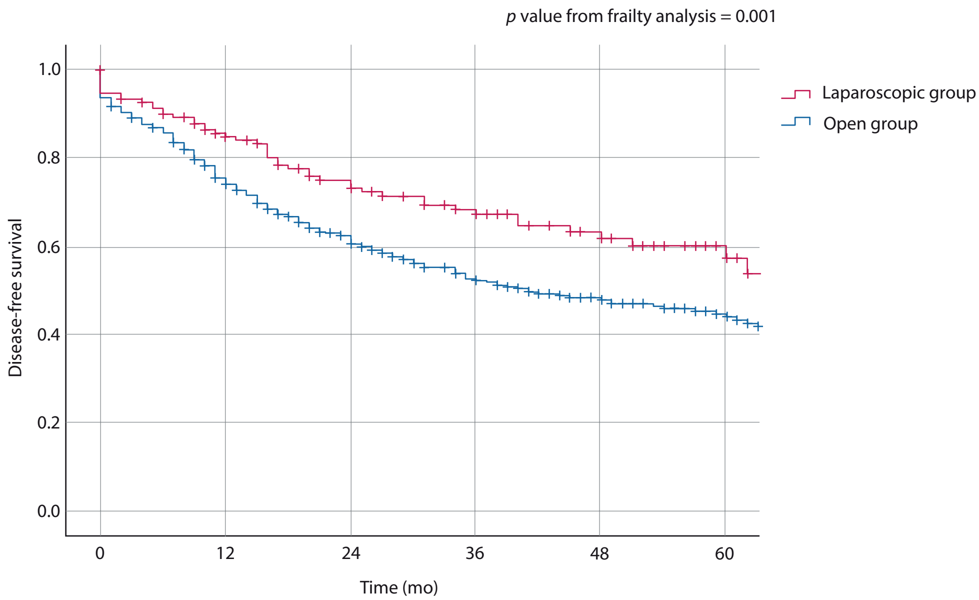
Number at risk	*12*	*24*	*36*	*48*	*60*
Laparoscopic group	128	98	79	47	23
Open group	368	282	200	128	87

FIGURE 2. Kaplan-Meier curves of overall survival in the matched cohort (n = 632).

have been shown previously. Our results are in line with a recent American nationwide retrospective cohort study of 1293 acutely treated colon cancer patients that also found significantly lower morbidity (50% vs 61.8%) and shorter length of stay.[8] Yet, we are the first to show an association between surgical approach in the emergency setting and survival. Few studies investigated long-term oncological outcomes after colon cancer surgery in this setting. No significant differences in survival have been observed so far,[9,12] but patient samples in these studies were too small, with fewer than 20 patients remaining at risk at 3 years of follow-up in both groups.

The lower overall 90-day complication rate in the laparoscopically treated patients is not surprising because it is known that laparoscopy is associated with fewer surgical site infections, fewer wound dehiscence, and reduced ileus rates in the elective setting.[18,19] This is straightforwardly explained by the smaller incisions resulting in less surgical trauma to the abdominal wall after laparoscopy. However, the observed benefit of laparoscopic emergency resection with regard to long-term oncological outcomes is remarkable. It is presumable that not the laparoscopic approach itself would provide better survival rates but the associated covariates. For example, the quicker recovery after laparoscopy surgery might translate into earlier initiation of adjuvant chemotherapy.[20] However, in our study, the proportion of patients receiving adjuvant chemotherapy within 8 and 12 weeks did not differ between the 2 groups. In addition, there were no significant differences in histopathological characteristics between the 2 groups with similar oncological quality of the resections regarding lymph node harvest and margin status. An alternative explanation could be that, as shown by several studies, postoperative complications are independently associated with a higher risk of developing disease recurrence.[21–24] Although no significant difference was found for intraperitoneal recurrence and distant metastases between both groups, the absolute numbers were lower for patients treated by laparoscopy, with a significantly higher disease-free survival. It has been reported that postoperative immunosuppression plays a role in cancer recurrence.[25] The postoperative immune status is associated with the severity of surgical trauma, with less immunosuppression after minimally invasive surgery. This might be an alternative explanation for our finding of longer disease-free survival after laparoscopy.

Beneficial survival rates after laparoscopy could also be explained by reduced noncancer-related deaths. Laparoscopy might reduce cardiopulmonary complications because of less surgical stress response and pain in the postoperative period, which are known to induce and underlie cardiopulmonary disease in the long term. This was not the scope of the present study, but previous studies in the elective setting showed a decreased cardiopulmonary complication rate after laparoscopy.[26] Furthermore, laparoscopy reduces the risk of small-bowel adhesions, and adhesion-related complications have been associated with mortality during long-term follow-up.[27]



Number at risk	*12*	*24*	*36*	*48*	*60*
Laparoscopic group	128	98	79	47	23
Open group	368	282	200	128	87

FIGURE 3. Kaplan-Meier curves of disease-free survival in the matched cohort (n = 632).

Two major issues should be taken into account before drawing definitive conclusions. Although we aimed to create 2 comparable groups by propensity score matching, there remains a reasonable risk of bias inherent to the retrospective nature of this study. First, we were not able to completely adjust for the clinical illness of the patient as, for example, cecal diameter had too many missing values to use this variable for matching. Presumably, unknown confounders have affected the choice of the type of surgery because patients with signs of sepsis are more likely to be treated with an open approach. However, we excluded all patients with signs of perforation, aiming to create a more homogenous patient population that could be treated by laparoscopy, and critical laboratory values such as CRP, leukocytes, and creatinine were comparable between the 2 groups. Furthermore, we adjusted for the presence of small-bowel distention and included subtotal colectomy as a reflection of the severity of colonic distention. Despite this, future (randomized) studies should stratify patients for CT parameters reflecting the degree of bowel distention, vital parameters, and a uniform clinical illness classification system such as the acute physiology and chronic health evaluation score (APACHE).

Second, there were no specific data on experience of surgeons who performed the resection. Therefore, the present analyses could not incorporate surgical experience regarding both oncological and minimally invasive surgery. The fact that only a minority of patients in this large nationwide study were treated by laparoscopy (<10%) suggests that experience with this technique in the emergency setting was still limited. Patients who were treated by laparoscopy might have been treated by more specialized, skilled surgeons during daytime, whereas unexperienced surgeons or residents on call at night would rather perform a laparotomy. However, this remains a point of debate in comparing laparoscopy with open surgery, even in the elective setting, because it is hard to stratify patients based on the experience of the surgeon on call without generating ungeneralizable results. These 2 issues are reflected in our cohort, as significantly more patients in the laparoscopy group underwent surgery >24 hours after initial presentation, whereas open patients were more likely to be treated immediately. However, we did include duration until surgery in our multivariable models of the original cohort afterward, which revealed that time to surgery had no effect on 90-day resection-related complications or on overall survival in this cohort. Finally, more primary anastomoses and fewer stomas in the laparoscopy group might also reflect a difference in experience and/or specialization of the operating surgeon between the laparoscopic and open groups.

Regarding the clinical implications of this study, one might conclude that an emergency laparoscopic resection is a more valid option in selected patients than an emergency open resection. However, the low uptake (10%) of laparoscopy as well as the high conversion rate (34.4%) in this cohort illustrates the challenges of an emergency laparoscopic resection. Even with increasing expertise over time, a significant proportion of patients is probably not amenable to undergo such a procedure because of technical difficulties. Therefore, one of the most important messages is that an open emergency resection should probably be avoided because this study showed emergency open resection to be associated with high complication rates and poor survival. If patients are not considered to be suitable for emergency laparoscopic resection or if relevant expertise is not available, a DS has been demonstrated to be a safer option with better long-term survival than an emergency open resection.[28] This suggestion is especially relevant for countries with an urban-rural divide, in which surgeons working in rural hospitals can perform a blow-hole colostomy and refer to a specialized cancer care center in a semielective setting. If the primary tumor is technically suitable for stenting and relevant expertise is available, a self-expandable metal stent might also be used as a bridge to surgery strategy after careful consideration of the pros and cons.[29]

Considering the high conversion rate, Li et al[30] described an alternative procedure with initial decompression of the bowel via the intended extraction site, which subsequently facilitates (hand-assisted) laparoscopic resection during the same procedure. For left-sided obstructions, one can start the procedure with a Pfannenstiel incision and colonic decompression by performing an appendectomy or small colotomy proximal to the tumor. Subsequently, a port can be placed at the Pfannenstiel incision with the placement of additional ports for laparoscopic resection of the primary tumor.

This study suggests a need for more training of residents and surgeons to become skilled in the use of laparoscopic colorectal surgery, even in the emergency setting, as well as an adequate occupancy by specialized colorectal surgeons.

CONCLUSION

Overall, the data of this propensity score–matched population-based study revealed that among patients undergoing emergency resection for LSOCC, those treated by intentional laparoscopy showed better short- and long-term outcomes than those treated by open emergency resection. Although it must be taken into account that bias cannot be completely ruled out because of the retrospective nature of this study, this study does provide the best available evidence up until now, and a higher level of evidence from randomized controlled trials in this setting is unlikely to be generated in the immediate future. Therefore, we conclude that open emergency resection in patients with LSOCC should probably be avoided, for example, by performing a DS, and emergency laparoscopic resection might be a valuable option in selected cases if relevant expertise is available.

ACKNOWLEDGMENTS

Dutch Snapshot Research Group: H Algera, GD Algie, CS Andeweg, TE Argillander, MNNJ Arron, K Arts, THJ Aufenacker, IS Bakker, M van Basten Batenburg, AJNM Bastiaansen, GL Beets, A van den Berg, B van de Beukel, RLGM Blom, B Blomberg, EG Boerma, FC den Boer, ND Bouvy, JE Bouwman, NDA Boye, ARM Brandt-Kerkhof, HT Bransma, A Breijer, WT van den Broek, MEE Bröker, JPM Burbach, ERJ Bruns, TA Burghgraef, RMPH Crolla, M Dam, L Daniels, A Demirkiran, KW van Dongen, SF Durmaz, A van Esch, JA van Essen, JW Foppen, EJB Furnee, AAW van Geloven, MF Gerhards, EA Gorter, WMU van Grevenstein, J van Groningen, IAJ de Groot-van Veen, HE Haak, JWA de Haas, P van Hagen, JTH Hamminga, K Havenga, B van den Hengel, E van der Harst, J Heemskerk, J Heeren, BHM Heijnen, L Heijnen, JT Heikens, M van Heinsbergen, DA Hess, N Heuchemer, C Hoff, W Hogendoorn, APJ Houdijk, N Hugen, B Inberg, TL Janssen, D Jean Pierre, WJ de Jong, ACHM Jongen, AV Kamman, JM Klaase, W Kelder, EF Kelling, R Klicks, GW De Klein, FWH Kloppenberg, JLM Konsten, LJER Koolen, V Kornmann, RTJ Kortekaas, A Kreiter, M Kusters, B Lamme, JF Lange, T Lettinga, D Lips, G Lo, F Logeman, YT van Loon, MF Lutke Holzik, CCM Marres, I Masselink, A Mearadji, G Meisen, AG Menon, JWS Merkus, DJLM de Mey, HCJ van der Mijle, DE Moes, CJL Molenaar, MJ Nieboer, K Nielsen, GAP Nieuwenhuijzen, PA Neijenhuis, P Oomen, N van Oorschot, K Parry, KCMJ Peeters, T Paulides, I Paulusma, FB Poelmann, SW Polle, P Poortman, MH Raber, RJ Renger, BMM Reiber, R Roukema, WMJ de Ruijter, MJAM Russchen, HJT Rutten, J Scheerhoorn, S Scheurs, H Schippers, VNE Schuermans, HJ Schuijt, JC Sierink, PD Siersema, C Sietses, R Silvis, J van der Slegt, GD Slooter, M van der Sluis, P van der Sluis, N Smakman, D Smit, AB Smits, TC van Sprundel, DJA Sonneveld, C Steur, J Straatman, MC Struijs, HA Swank, AK Talsma, M Tenhagen, JAMG Tol, JL Tolenaar, L Tseng, MJF van Veen, SC Veltkamp, AWH van de Ven, L Verkoele, M Vermaas, HP Versteegh, L Verslijs, T Visser, D van Uden, WJ Vles, RJ de Vos tot Nederveen Cappel, HS de Vries, ST van Vugt, G Vugts, JA Wegdam, TJ Weijs, BJ van Wely, B Wiering, NAT Wijffels, AA Wijkmans, LH Wijngaarden, JHW de Wilt, M van de Wilt, DD Wisselink, F Wit, DDE Zimmerman, and TLR Zwols.

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