Retrospective Cohort Study

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Timing of restoration of bowel continuity after decompressing stoma, in left-sided obstructive colon cancer: a nationwide retrospective cohort

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Background: With the increasing use of decompressing stoma as a bridge to surgery for left-sided obstructive colon cancer (LSOCC), the timing of restoration of bowel continuity (ROBC) is a subject of debate. There is a lack of data on immediate ROBC during elective resection as an alternative for a 3-stage procedure. This study analysed if immediate ROBC during tumour resection is safe and of any benefit for patients who underwent decompressing stoma for LSOCC.

Methods: In a Dutch nationwide collaborative research project, 3153 patients who underwent resection for LSOCC in 75 hospitals (2009–2016) were identified. Extensive data on disease and procedural characteristics, and outcomes was collected by local collaborators. For this analysis, 332 patients who underwent decompressing stoma followed by curative resection were selected. Immediate ROBC during tumour resection was compared to two no immediate ROBC groups, (1) tumour resection with primary anastomosis (PA) with leaving the decompressing stoma in situ, and (2) tumour resection without PA.

Results: Immediate ROBC was performed in 113 patients (34.0%) and no immediate ROBC in 219 patients [168 with PA (50.6%) and 51 patients without PA (15.4%)]. No differences at baseline between the groups were found for age, ASA score, cT, and cM. Major surgical complications (8.8% immediate ROBC vs. 4.8% PA with decompressing stoma and 7.8% no PA; $P = 0.37$) and mortality (2.7% vs. 2.4% and 0%, respectively; $P = 0.52$) were similar. Immediate ROBC resulted in a shorter time with a stoma (mean 41 vs. 240 and 314 days, respectively; $P < 0.001$), and fewer permanent stomas (7% vs. 21% and 80%, respectively; $P < 0.001$) as compared to PA with a decompressing stoma or no PA.

Conclusion: After a decompressing stoma for LSOCC, immediate ROBC during elective resection appears safe, reduces the total time with a stoma and the risk of a permanent stoma.

Introduction

Patients with acute left-sided obstructive colon cancer (LSOCC) can be treated with either emergency resection, or a bridge to surgery (BTS) strategy using a self-expandable metal stent or a decompressing stoma. Previous studies have demonstrated the advantages of the decompressing stoma as BTS in LSOCC, compared with emergency resection[1,2]. Compared with self-expandable metal stent, a the decompressing stoma as BTS is the associated with advantages and disadvantages, without a clear preference in patients who are suitable for both options[3]. However, decompressing stoma as BTS can be performed independent from tumour characteristics and does not require specific endoscopic expertise. Therefore, a continuous increase of its use has been observed[4]. An unresolved issue in decompressing stoma as BTS is timing of restoration of bowel continuity (ROBC).

Three different stoma reversal strategies can be followed after the decompressing stoma as BTS. At first, the stoma can immediately be reversed during tumour resection with primary anastomosis (PA). This strategy will omit an additional operation to reverse any remaining stoma after tumour resection. However, it is believed that this might increase the risk of morbidity, including anastomotic leakage[5]. An alternative strategy is to leave the decompressing stoma in situ, which will divert the PA, thereby reducing the risk of symptomatic anastomotic leakage[6]. Besides the necessity of a 3-stage procedure, the stoma will be in place for a longer time with the risk of more stoma-related complications. The third option is to primarily place the decompressing stoma near the segment that will be resected. During tumour resection, no anastomosis is created and the decompressing stoma will

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become an end-colostomy. In a later stage, bowel continuity can be restored.

Evidence supporting one method over the other in terms of patient outcomes is lacking. Therefore, the objective of the current study is to analyse morbidity, mortality, time with a stoma in situ, and risk of permanent stoma after immediate ROBC in patients who underwent decompressing stoma for LSOCC, and to compare this with patients in whom bowel continuity was not immediately restored.

Materials and methods

Design

The population of the present study was selected from a large national collaborative research project on LSOCC that was performed in the Netherlands by the Dutch Snapshot Research Group (DSRG)[4]. In short, 3153 patients were identified from the Dutch colorectal audit (DCRA) who had a resection for acute LSOCC from 1 January 2009 to 31 December 2016. The short-term outcomes of these patients were retrieved and verified. Additionally, this database was extended with data on disease and procedural characteristics as well as additional short-term and long-term outcomes, by surgical residents of 75 Dutch hospitals. The methodology is described in detail in the first publication of the DSRG[7]. The institutional Review Board of the Academic Medical Centre in Amsterdam, The Netherlands, approved this study (W17_060-17.077). Exemption status for individual informed consent was provided due to the retrospective design with anonymized data. This study was registered at the Research Registry (www.researchregistry.com). The present work has been reported in line with the strengthening the reporting of cohort, cross-sectional and case–control studies in surgery (STROCSS) criteria[8].

Population

The inclusion criteria of the original cohort were (1) left-sided colon cancer (splenic flexure, descending colon, and sigmoid) with (2) symptomatic acute colonic obstruction (distended abdomen, nausea, and/or vomiting), (3) proven obstruction without free air on a radiograph or CT scan (distended colon and/or small bowel proximal to the tumour). Exclusion criteria included a benign tumour, rectal cancer, no acute obstruction, more than one colon tumour, a second malignancy, no resection, palliative treatment, obstruction which was resolved without intervention, no DS as BTS, and missing stoma data. For the purpose of the present study, only patients who had a decompressing stoma followed by resection of the primary tumour with curative intent were included. These patients were then categorised into three groups directly after primary tumour resection: (1) Immediate ROBC with PA and stoma reversal, (2) PA with leaving the decompressing stoma in situ, and (3) no PA. Together, groups 2 and 3 were classified as no immediate ROBC.

Outcome measures

The main outcome parameters were 90-day major surgical complications and mortality, total number of days with stoma in situ, and permanent stoma rate. Secondary outcomes were stoma location after resection (if present), hospital stay for primary tumour resection and total hospital stay, overall complications, proportion of adjuvant chemotherapy, 3-year disease-free survival (DFS), and 3-year overall survival (OS).

Definitions

Overall complications included both surgical and non-surgical complications, related to tumour resection and stoma-related interventions. Major surgical complications included complications that needed surgical or radiological interventions. Total hospital stay was defined as the number of days admitted to the hospital including readmission(s) related to index surgery. A permanent stoma was a stoma being present at the end of follow-up, with a minimum follow-up/survival of 6 months. The total time of having a stoma was defined as the number of days with a stoma in situ until stoma reversal. DFS was defined as the interval between the first presentation with acute LSOCC until locoregional recurrence, distant metastasis, death, or the last follow-up date. OS included the interval between the first presentation until death from any cause or last follow-up.

Statistical analysis

Continuous values were shown as median [interquartile range, (IQRs)] or as mean (SD). The three groups were compared using the Kruskal–Wallis *H* test (non-normally distributed) or one-way ANOVA (normally distributed), to analyse if the means/medians differed. Categorical variables were shown as numbers and percentages. A comparison of the categorical variables was performed using χ^2 test, with an additional comparison of the column proportions using the Bonferroni method. The total time of having a stoma was calculated using patients who had their stoma reversed, excluding patients with a permanent stoma from stoma placement till Kaplan–Meier curves and survival tables were plotted for DFS and OS, and comparisons were performed using Log-rank test (pairwise over strata). Predictors for the main outcomes were analysed using logistic regression (binary outcomes) or Cox regression (survival) in a multivariable model. The baseline variables age (continuous), sex, American Society of Anaesthesiology (ASA), BMI (continuous), cT, cM, and approach were selected for the multivariable model, based on clinical experience. In addition, the proportional hazard assumption was tested. A two-sided *P*-value of <0.05 was considered statistically significant. All analyses were performed using IBM SPSS Statistics, version 27 (IBM Corp).

Results

In total, 75 out of 77 hospitals in The Netherlands participated, with inclusion of 3153 patients in the original cohort. A total of 332 patients were included for the present analysis (Fig. 1). Immediate ROBC was performed in 113 patients (34.0%). No immediate ROBC was performed in the remaining 219 patients (66.0%): 168 patients (50.6%) underwent PA with leaving the decompressing stoma in situ, and in 51 patients (15.4%) there was no PA constructed (Fig. 2).

Baseline characteristics

There were no baseline differences in age ($P=0.79$), ASA score ($P=0.98$), previous abdominal surgery ($P=0.65$), cT stage ($P=0.18$), cM stage ($P=0.52$), and neoadjuvant chemotherapy ($P=0.52$) (Table 1). Some other characteristics did show

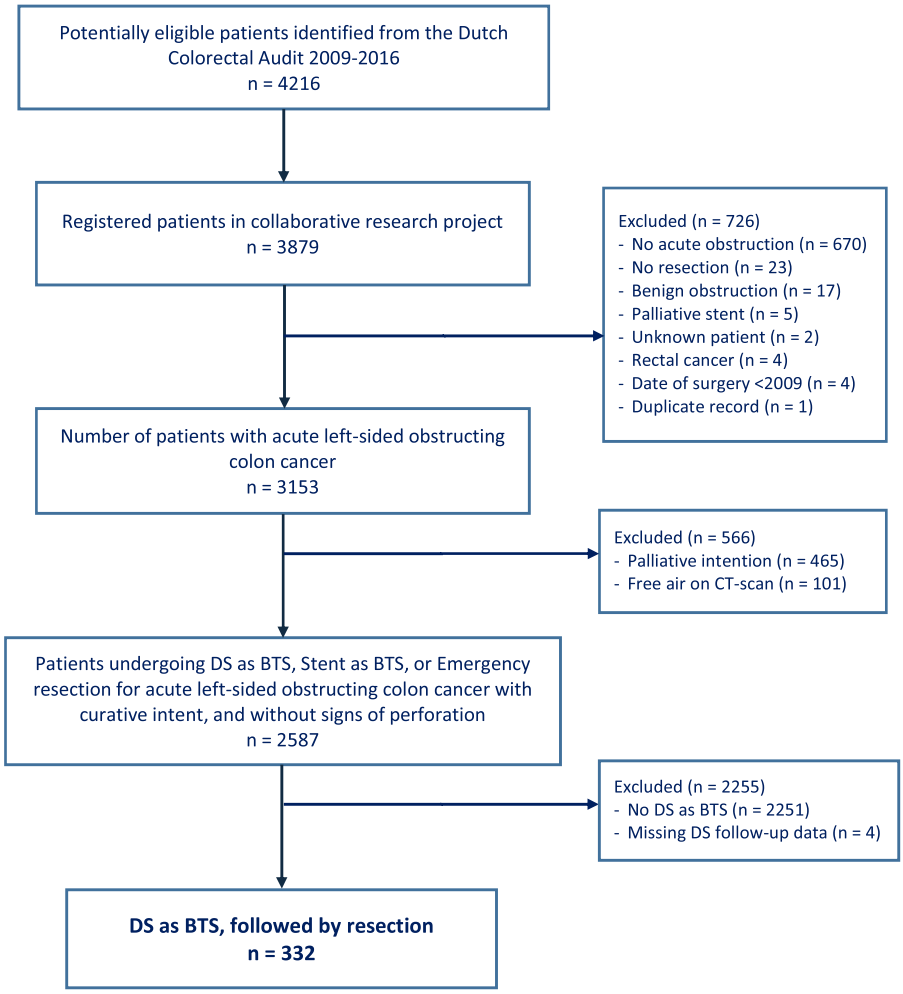

Figure 1. Patient flow of study participants. BTS, bridge to surgery; CT, computed tomography; DS, decompressing stoma.

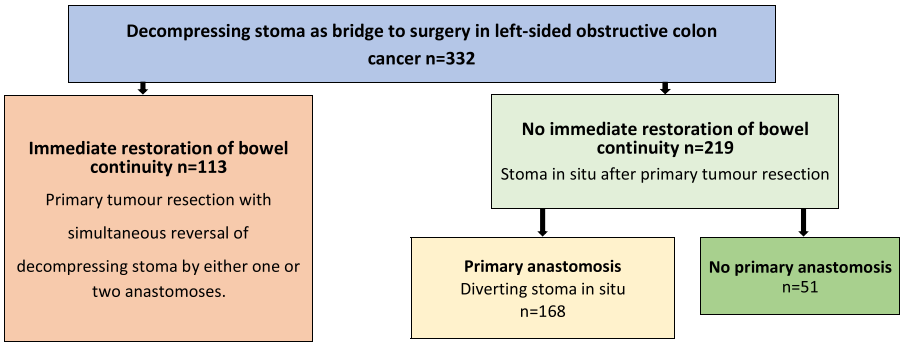

Figure 2. Flowchart of different strategies during resection of LSOCC, after decompressing stoma as BTS. BTS, bridge to surgery; LSOCC, left-sided obstructive colon cancer.

significant differences between the groups. Patients without PA had more often a BMI less than 18.5 compared with patients with PA and a decompressing stoma in situ (9.8 vs 1.8%, respectively; $P = 0.033$). Patients with immediate ROBC had more often a tumour located at the splenic flexure (29.2%) and less often at the sigmoid (51.3%) compared with the no immediate ROBC groups. In patients without PA, the decompressing stoma was more frequently placed at the level of the descending colon, and less often an ileostomy was constructed compared with the other groups (Table 1; $P < 0.001$). In patients with PA and decompressing stoma in situ fewer re-interventions in the BTS interval were performed, compared with the other groups (Table 1; $P = 0.008$).

Table 1

Baseline characteristics and management before resection of left-sided obstructive colon cancer, in patients who had a decompressing stoma as briddg to e#to#surgery.

Variable	Group	Total *n* (%)	Immediate restoration of bowel continuity (%)	No immediate restoration of bowel continuity (%)		*P*
				With PA and stoma in situ	Without PA	
Total	*n* (%)	332 (100)	113 (34.0)	168 (50.6)	51 (15.4)	–
Age in years	Median (IQR)	68 (59–76)	68 (60–77)	69 (57–76)	67 (58–79)	0.79
Sex	Male	196 (59.0)	77 (68.1)	93 (55.4)	26 (51.0)	0.05
ASA score	I–II	257 (77.4)	88 (77.9)	130 (77.4)	39 (76.5)	0.98
	III–IV	75 (22.6)	25 (22.1)	26 (19.5)	12 (23.5)	
BMI (kg/m^2)	18.5–25.0	163 (49.1)	54 (47.8)a	82 (48.8)a	27 (52.9)a	0.033
	< 18.5	12 (3.6)	4 (3.5)a, b	3 (1.8)b	5 (9.8)a	
	25.0–30.0	108 (32.5)	37 (32.7)a	56 (33.3)a	15 (29.4)a	
	> 30.0	31 (9.3)	10 (8.8)a	17 (10.1)a	4 (7.8)a	
	Missing	18 (5.4)	8 (7.1)a	10 (6.0)a	0 (0)a	
Previous abdominal surgery	Yes	124 (37.3)	41 (36.3)	61 (36.3)	22 (43.1)	0.65
Tumour location	Splenic flexure	52 (15.7)	33 (29.2)a	11 (6.5)b	8 (15.7)a, b	< 0.001
	Descending colon	56 (16.9)	22 (19.5)a	27 (16.1)a	7 (13.7)a	
	Sigmoid	224 (67.5)	58 (51.3)a	130 (77.4)b	36 (70.6)a, b	
cT stage	cT1–cT3, cTx	292 (88.0)	102 (90.3)	149 (88.7)	41 (80.4)	0.18
	cT4	40 (12.0)	11 (9.7)	19 (11.3)	10 (19.6)	
cM stage	cM0, cMx	299 (90.1)	104 (92.0)	151 (89.9)	44 (86.3)	0.52
	cM1	33 (9.9)	9 (8.0)	17 (10.1)	7 (13.7)	
Decompressing stoma location	Transverse colon	246 (74.1)	84 (74.3)a, b	131 (78.0)b	31 (60.8)a	< 0.001
	Ileum	38 (11.4)	8 (7.1)a	28 (16.7)b	2 (3.9)c	
	Descending colon	26 (7.8)	10 (8.8)a	1 (0.6)b	15 (29.4)c	
	Ascending colon	8 (2.4)	4 (3.5)a	3 (1.8)a	2 (3.9)a	
	Missing	14 (4.2)	7 (6.2)	5 (3.0)	0 (0)	
Neoadjuvant chemotherapy	Yes	49 (14.8)	14 (12.4)	25 (14.9)	10 (19.6)	0.52
	Missing	12 (3.6)	5 (4.4)	4 (2.4)	3 (5.9)	
Interval DS to resection in days	Median (IQR)	36 (21–67)	41 (24–66)	32 (21–63)	40 (18–109)	0.30
Complication of DS during BTS interval	Yes	27 (8.1)	12 (10.6)	10 (6.0)	5 (9.8)	0.44
	Missing	29 (8.7)	11 (9.7)	12 (7.1)	6 (11.8)	
Readmission during BTS interval	Yes	21 (6.3)	6 (5.3)	12 (7.1)	3 (5.9)	0.85
	Missing	41 (12.3)	15 (13.3)	18 (10.7)	8 (15.7)	
Reintervention during BTS interval	Yes	12 (3.6)	7 (6.2)a	1 (0.6)b	4 (7.8)a	0.008
	Radiological abscess drainage	3	2	0	1	
	Surgical due to SSI	9	5	1	3	
	Missing	22 (6.6)	8 (7.1)	10 (6.0)	4 (7.8)	

Each letter denotes a subset of 'Restoration type' whose column proportions do not differ significantly from each other at the 0.05 level.
ASA, American Society of Anaesthesiology; BTS, Briddg to e#to#surgery; cM, clinical Metastasis stage; cT, clinical tumour stage; DS, decompressing stoma; IQR, interquartile range; *P*, *P*-value; PA, primary anastomosis; SSI, surgical site infection.

Procedural characteristics

Tumour resection was performed more frequently using laparotomy in the group without PA (82.4%) compared with the immediate ROBC (53.1%) and the PA with decompressing stoma group (41.7%) ($P < 0.001$). More often sigmoid resection was performed in patients who received PA with a decompressing stoma in situ (72.6%), as compared to the immediate ROBC (45.1%) and no PA (56.9%) groups. Stoma location after resection in the groups without immediate ROBC differed significantly, with more ileostomies (22.6 vs 9.8%) and transverse colostomies (73.2 vs 41.2%) in patients with a PA and decompressing stoma as compared to those without PA. More details are provided in Table 2.

Table 2

Procedural characteristics and short-term outcomes after resection of left-sided obstructive colon cancer, in patients who had a decompressing stoma as briddg to e#to#surgery.

			No immediate restoration of bowel continuity (%)		
Variable	**Group**	**Immediate restoration of bowel continuity (%)**	**With PA and stoma in situ**	**Without PA**	***P***
Total *n* (%)	332 (100)	113 (34.0)	168 (50.6)	51 (15.4)	–
Approach	Open	60 (53.1)a	70 (41.7)a	42 (82.4)b	< 0.001
	Laparoscopic	53 (46.9)a	98 (58.3)a	9 (17.6)b	
	Conversion of laparoscopy	11 (20.8)a	16 (16.3)a	0 (0)b	
Type of resection	Subtotal colectomy	6 (5.3)a, b	6 (3.6)b	6 (11.8)a	< 0.001
	Transverse resection	0 (0)a	1 (0.6)a	1 (2.0)a	
	Extended left hemicolectomy	4 (3.5)a	0 (0)b	4 (7.8)a	
	Left hemicolectomy	52 (46.0)a	39 (23.2)b	11 (21.6)b	
	Sigmoid resection	51 (45.1)a	122 (72.6)b	29 (56.9)a	
Location of stoma in situ directly after resection	Ileostomy	–	38 (22.6)a	5 (9.8)b	< 0.001
	Ascending colostomy	–	3 (1.8)a	1 (2.0)a	
	Transverse colostomy	–	123 (73.2)a	21 (41.2)b	
	Descending colostomy	–	0(0)a	21 (41.2)b	
	No stoma in situ	113 (100)a	0 (0)b	0 (0)b	
	Missing	0 (0)	4 (2.4)	3 (5.9)	
Hospital stay directly after resection in days	Median (IQR)	7 (5–11)a	6 (4–9)a	12 (9–21)b	< 0.001
All complications	< 90 days after resection	44 (39.3)a	41 (24.7)b	17 (34.0)a, b	0.01
	> 90 days after resection[a]	3 (4.4)a	35 (28.0)b	8 (24.2)b	< 0.001
	Complete follow-up	47 (42.0)	76 (45.8)	25 (50.0)	0.62
Resection-related surgical complications <90 days	All surgical complications	37 (32.7)a	33 (19.6)b	13 (25.5)a, b	0.013
	Major surgical complications	10 (8.8)	8 (4.8)	4 (7.8)	0.37
	Anastomotic leakage	9 (8.0)a	3 (1.8)b	–	0.012
	Intra-abdominal abscess	2 (1.8)	5 (3.0)	4 (7.8)	0.13
	Fascial dehiscence	5 (4.7)a	0 (0)b	2 (4.2)a	0.006
	Wound infection	13 (11.9)	17 (10.4)	2 (4.2)	0.32
	Postoperative ileus	7 (6.5)a	1 (0.6)b	2 (4.2)a, b	0.005
	Bleeding	1 (0.9)	2 (1.2)	0 (0)	0.74
Postoperative mortality	< 90 days after resection	3 (2.7)	4 (2.4)	0 (0)	0.52
Adjuvant chemotherapy	Received	47 (42.0)	69 (42.1)	17 (33.3)	0.51

Each letter denotes a subset of 'Restoration type' whose column proportions do not differ significantly from each other at the 0.05 level.
IQR, interquartile range; *P, P*-value; PA, primary anastomosis.
[a]This includes complications related to new interventions (e.g. restoration of bowel continuity).

Short-term outcomes

Significantly more complications within 90 days after resection were observed in the immediate ROBC group compared with the no immediate ROBC with PA group (39.3 vs 24.7%, respectively; $P = 0.01$). Surgical complications within 90 days after resection were significantly higher in the immediate ROBC group (32.7%; $P = 0.013$) compared with the no immediate ROBC with PA group (19.6%) (Table 2). This was mainly due to the higher rate of anastomotic leakage (8.0 vs 1.8%, respectively; $P = 0.012$), fascial dehiscence (4.7 vs 0%, respectively; $P = 0.006$) and more postoperative ileus (6.5 vs 0.6%, respectively; $P = 0.005$) within 90 days after resection. Major surgical complications occurred in 8.8% after immediate ROBC, which was not significantly higher than the no immediate ROBC groups (4.8 and 7.8%, respectively; $P = 0.37$). Ninety-day mortality after resection was not different between the groups (2.7 vs. 2.4% and 0%, respectively; $P = 0.52$). Median hospital stay, directly after resection, was longer in the no PA group (12 days, IQR 9–12; $P < 0.001$) compared with the immediate ROBC group (7 days, IQR 5–11) and the no immediate ROBC with PA group (6 days, IQR 4–9).

Long-term outcomes

Table 3 shows an overview of the long-term outcomes. Median follow-up did not differ between the groups ($P = 0.66$). The complication rate after 90 days was significantly lower in the immediate ROBC group (4.4%; $P < 0.001$) compared with the no immediate ROBC groups (28.0% with PA and 24.2% without PA). Overall complications during the complete follow-up demonstrated no difference between the groups. Total hospital stay was significantly longer in the no immediate ROBC without

Table 3

Long-term outcomes after resection of left-sided obstructive colon cancer, in patients who had a decompressing stoma as briddg to e#to#surgery.

Variable	Immediate restoration of bowel continuity	No immediate restoration of bowel continuity		*P*
		With PA & stoma in situ	Without PA	
Total *N* (%)	113 (34.0)	168 (50.6)	51 (15.4)	–
Follow-up in months, median (IQR)	24 (12–47)	23 (14–47)	28 (19–40)	0.66
Total admittance in days, median (IQR)[a]	16 (13–26)a	16 (12–23)a	32 (23–47)b	< 0.001
Total days with stoma, median (IQR)[a]	41 (27–63)a	240 (134–334)b	304 (152–361)b	< 0.001
Permanent stoma[b], *N* (%)	7 (7.0)a	32 (21.2)b	37 (80.4)c	< 0.001
3-year disease-free survival (%)	71.7a	57.3a, b	51.3b	0.014
No of events at 36 months of follow-up	23	56	19	
No of patients at risk after 36 months of follow-up	31	50	13	
3-year overall survival (%)	81.7a	71.1a, b	71.5b	0.030
No of events at 36 months of follow-up	13	33	11	
No of patients at risk after 36 months of follow-up	37	53	18	

Each letter denotes a subset of 'Restoration type' whose column proportions do not differ significantly from each other at the 0.05 level.
IQR, interquartile range, *P, P*-value; PA, primary anastomosis.
[a]Excluding patients with a stoma at the end of follow-up.
[b]With a minimum follow-up/survival of 6 months.

PA group (32 days, IQR 23–47; $P < 0.001$) compared with the immediate ROBC group (16 days, IQR 13–26) and no immediate ROBC with PA group (16 days, IQR 12–23).

The time with a stoma in situ was shorter in the immediate ROBC group (41 days, IQR 27–63; $P < 0.001$) than in the no immediate ROBC groups: 240 days (IQR 134–334) with PA and 304 days (IQR 152–361) without PA. The permanent stoma rate was 7.0% in the immediate ROBC group, 21.2% in the no immediate ROBC with PA group and 80.4% in the no immediate ROBC without PA group ($P < 0.001$).

Table 4

Univariable and multivariable analysis of the main outcomes.

All complications, complete follow-up					Surgical complications <90 days			
	Univariable analysis		Multivariable analysis[a]		Univariable analysis		Multivariable analysis[a]	
Timing of restoration	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*
Immediate ROBC	Reference	–	Reference	–	Reference	–	Reference	–
No immediate ROBC with PA	1.17 (0.72–1.90)	0.53	1.17 (0.69–1.98)	0.56	0.52 (0.30–0.90)	0.02	0.51 (0.27–0.93)	0.03
No immediate ROBC without PA	1.38 (0.71–2.70)	0.34	1.32 (0.65–2.68)	0.44	0.73 (0.35–1.54)	0.41	0.54 (0.24–1.22)	0.14
Anastomotic leakage <90 days					Permanent stoma[b]			
	Univariable analysis		Multivariable analysis[a]		Univariable analysis		Multivariable analysis[a]	
Timing of restoration	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*
Immediate ROBC	Reference	–	Reference	–	Reference	–	Reference	–
No immediate ROBC with PA	0.21 (0.06–0.79)	0.02	0.25 (0.06–1.14)	0.07	3.82 (1.62–9.01)	0.002	4.28 (1.90–9.66)	< 0.001
No immediate ROBC without PA	Not applicable	–	Not applicable	–	49.65 (17.16–143.77)	< 0.001	41.79 (14.89–117.26)	< 0.001
3-year disease-free survival					3-year overall survival			
	Univariable analysis		Multivariable analysis[a]		Univariable analysis		Multivariable analysis[a]	
Timing of restoration	HR (95% CI)	*P*	HR (95% CI)	*P*	HR (95% CI)	*P*	HR (95% CI)	*P*
Immediate ROBC	Reference	–	Reference	–	Reference	–	Reference	–
No immediate ROBC with PA	1.50 (0.98–2.29)	0.06	1.22 (0.72–2.06)	0.45	1.50 (0.87–2.60)	0.14	1.13 (0.57–2.25)	0.72
No immediate ROBC without PA	1.95 (1.15–3.31)	0.01	1.78 (1.00–3.16)	0.05	2.03 (1.06–3.92)	0.03	1.50 (0.73–3.10)	0.27

HR, hazard ratio; OR, odds ratio; PA, primary anastomosis; ROBC, restoration of bowel continuity.
[a]Multivariable analysis adjusted for Age, Sex, ASA, BMI, tumour location, pT stage, c/pM stage, Approach.
[b]With a minimum follow-up/survival of 6 months.

In univariable analysis, 3-year DFS was higher in the immediate ROBC group (71.7%; $P = 0.014$) compared with the no immediate ROBC without PA group (51.3%). Three-year OS was higher in the immediate ROBC group (81.7%; $P = 0.030$) compared with the no immediate ROBC without PA group (71.5%) (Table 3). In the multivariable Cox regression-analysis, 3-year DFS and 3-year OS were not different between the groups (Table 4). Finally, the proportional hazard assumption demonstrated that the hazard ratio was constant over time.

Discussion

In this subgroup analysis of a nationwide cohort, timing of ROBC in patients who initially underwent a decompressing stoma had notable effects on patient outcomes. Immediate ROBC during resection of the primary tumour did not result in a higher rate of major surgical complications than leaving a stoma in place, either with or without a PA. Postoperative mortality after immediate ROBC was low (2.7%) and did not differ from the other groups. Although any complications occurred more often within 90 days after immediate ROBC, less complications occurred thereafter, resulting in a nondifferent overall complication rate among the three groups. No immediate ROBC resulted in a substantially longer time with a stoma (mean difference >200 days). Immediate ROBC resulted in only 7% risk of permanent stoma. If a PA was constructed during resection and the decompressing stoma was left in situ, the permanent stoma rate was 21%. If no PA was constructed during resection, the stoma was reversed in only a minority of patients (80% permanent stoma rate).

The most common strategy in this population-based study was to construct a PA during primary tumour resection, but to leave the decompressing stoma in situ. It is hypothesised that this approach decreases the risk of anastomotic leakage, and therefore reduces major complications and mortality, compared with immediate ROBC. The current study confirms that anastomotic leakage occurs less often if the decompressing stoma was left in situ, but those patients might be at risk of anastomotic leakage later on when restorative surgery is performed. Unfortunately, these anastomotic leakages were only included in the overall complications after 90 days, because they were not specifically scored as such. This has likely led to an underestimation of overall anastomotic leak rates in the no immediate ROBC groups. Although more anastomotic leakage within 90 days after immediate ROBC was observed, this did not lead to an increase in major surgical complications or mortality. Thus, if a PA is constructed, leaving a decompressing stoma in situ seems unnecessary. There might be allocation bias, and it should be emphasised that the patients were not randomly assigned to either of the three strategies. Nevertheless, there was a remarkable similarity in most of the baseline characteristics including age and ASA score, which strengthen our findings.

Studies describing the morbidity related to the timing of ROBC in patients with LSOCC who underwent a decompressing stoma are scarce. To the best of our knowledge, the single-centre retrospective study by Lin *et al*.[5] is the only previous paper that analysed ROBC in LSOCC. Their data demonstrated no difference in anastomotic leakage and mortality between two-stage and three-stage restoration. However, Lin *et al*. demonstrated only one anastomotic leakage and no mortality[5]. These low anastomotic leakage and mortality rates, together with the single-centre design, might not be representative. Many rectal cancer studies on ROBC have been performed[6,9–11]. However, rectal cancer is a different entity, and it is debatable if these results can be compared with LSOCC.

In the no immediate ROBC groups, patients had their stoma in situ for a substantially longer time compared with the immediate ROBC group. A longer time with stoma correlates with higher medical costs and a lower quality of life, mainly due to an increase in stoma-related complications[12–14]. Apart from complications related to the additional restorative surgery, this might also explain the increased rate of complications after 90 days in the no immediate ROBC groups. Furthermore, the permanent stoma rate was significantly higher in the no immediate ROBC groups with associated morbidity and lower quality of life[15–17]. If no PA was constructed, this might already have been with the intention not to restore bowel continuity later on, which is reflected by the 80.4% permanent stoma rate. However, if a PA was constructed but the decompressing stoma was left in situ, this was likely intended to be a temporary stoma. Nevertheless, 21.2% did not have ROBC, which was substantially higher than the 7% permanent stoma rate in the immediate ROBC group. If the goal is to restore bowel continuity, the latter seems a preferable strategy.

Limitations

The limitations of this study include the retrospective design. Some data was lacking, including data concerning the type of long-term complications, considerations for the timing of restoration, and reason why ROBC was not performed. The reason for the timing of restoration can be surgeon dependent, as well as the decision to perform a PA when choosing for a no immediate ROBC strategy. Furthermore, even though baseline characteristics were similar across the groups, confounding cannot be ruled out. By performing multivariable analyses, using possible confounders, this risk was minimised.

In conclusion, immediate ROBC during resection of LSOCC, after initial decompressing stoma as BTS, did not lead to more morbidity or mortality compared to no immediate ROBC. Moreover, immediate ROBC reduces the time that patients have a stoma in situ and the risk of a permanent stoma. The authors advocate to consider immediate ROBC in these patients in order to avoid additional restoration surgery and to improve quality of life.

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Ethical approval

The institutional Review Board of the Academic Medical Centre in Amsterdam, the Netherlands, approved this study. Exemption status for individual informed consent was provided due to the retrospective design with anonymized data. Reference name: 'Snapshot – Linkszijdig obstructief colon carcinoom'. Reference number: W17_060-17.077.

Consent

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Author contribution

Dr Z.: had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis; Z., V., C., T., and v.W.: concept and design; Z., V., B., C., T., and v.W.: acquisition, analysis, or interpretation of data; Z., V., and v.W.: draughting of the manuscript; Z., V., B., C., T., and v. W.: critical revision of the manuscript for important intellectual content; Z., V., and B.: statistical analysis; V. and T.: obtained funding; B., C., T., and v.W.: supervision.

Conflicts of interest disclosure

None.

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Data availability statement

(It is unclear and not mentioned in the instructions what is required.) All data is original data and not published elsewhere. All further information is stated in the manuscript.

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