ORIGINAL CONTRIBUTION

Outcomes After Elective Versus Emergency Resection for Right-Sided Colon Cancer: A Propensity Score-Matched Analysis

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BACKGROUND: Previous studies reported similar complication rates, including anastomotic leakage, after elective and emergency surgery for right-sided colon cancer. This led to the consensus that emergency resection with primary anastomosis is safe. However, recent evidence suggests higher complication rates after emergency surgery, indicating that alternative strategies, such as a bridge to surgery, may be more suitable.

OBJECTIVE: To assess whether complication rates, particularly anastomotic leakage, are higher after emergency resections compared to elective resections in patients with right-sided colon cancer.

DESIGN: A retrospective cohort study using data from the Dutch ColoRectal Audit from 2010 to 2019.

SETTINGS: Nationwide data from hospitals across the Netherlands.

PATIENTS: Patients who underwent resection for right-sided colon cancer (n = 5056 emergency resections matched 1:1 to elective resections using propensity score matching).

MAIN OUTCOME MEASURES: Incidence of anastomotic leakage, 90-day complication rates, and mortality rates after elective versus emergency surgery for right-sided colon cancer.

RESULTS: After matching, no significant baseline differences remained. There was no significant difference in anastomotic leakage rates. However, the mortality rate was twice as high in the emergency group (9.4% vs 4.2%, $p < 0.001$), and the 90-day complication rate was also higher (41.7% vs 33.0%, $p < 0.001$).

LIMITATIONS: Minimal missing data were handled with multiple imputation. Although propensity score matching was used, bias from unknown confounders may persist. The emergency group included more high-risk patients, potentially influencing outcomes.

CONCLUSIONS: Emergency resections for right-sided colon cancer are associated with higher complication and mortality rates compared to elective surgery. A bridge-to-surgery approach could reduce these risks by converting emergency cases to elective procedures. Further research is needed to validate these findings. See **Video Abstract**.

RESULTADOS TRAS LA RESECCIÓN ELECTIVA FRENTE A LA RESECCIÓN DE EMERGENCIA PARA CÁNCER DE COLON DEL LADO DERECHO: UN ANÁLISIS DE PUNTUACIÓN DE PROPENSIÓN COINCIDENTE

ANTECEDENTES: Estudios previos informaron tasas de complicaciones similares, incluida la fuga anastomótica, después de una cirugía electiva y de emergencia para el cáncer de colon del lado derecho. Esto llevó al consenso de que la resección de emergencia con anastomosis primaria es segura. Sin embargo, evidencia reciente sugiere tasas de complicaciones más altas después de la cirugía de emergencia, lo que indica que las estrategias alternativas, como un puente a la cirugía, pueden ser más adecuadas.

OBJETIVO: Evaluar si las tasas de complicaciones, en particular la fuga anastomótica, son más altas después

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de las resecciones de emergencia en comparación con las resecciones electivas en pacientes con cáncer de colon del lado derecho.

DISEÑO: Un estudio de cohorte retrospectivo que utiliza datos de la Dutch ColoRectal Audit de 2010 a 2019.

ESCENARIO: Datos a nivel nacional de hospitales de los Países Bajos.

PACIENTES: Pacientes que se sometieron a una resección por cáncer de colon del lado derecho (n = 5056 resecciones de emergencia emparejadas 1:1 con resecciones electivas mediante emparejamiento por puntaje de propensión).

PRINCIPALES MEDIDAS DE VALORACIÓN: Incidencia de fuga anastomótica, tasas de complicaciones a los 90 días y tasas de mortalidad después de cirugía electiva versus cirugía de emergencia para cáncer de colon del lado derecho.

RESULTADOS: Después del emparejamiento, no se mantuvieron diferencias significativas al inicio. No hubo diferencias significativas en las tasas de fuga anastomótica. Sin embargo, la tasa de mortalidad fue dos veces más alta en el grupo de emergencia (9,4% frente a 4,2%, $p < 0{,}001$) y la tasa de complicaciones a los 90 días también fue mayor (41,7% frente a 33,0%, $p < 0{,}001$).

LIMITACIONES: Los datos faltantes mínimos se manejaron con imputación múltiple. Si bien se utilizó el emparejamiento por puntaje de propensión, puede persistir el sesgo de factores de confusión desconocidos. El grupo de emergencia incluyó más pacientes de alto riesgo, lo que potencialmente influyó en los resultados.

CONCLUSIONES: Las resecciones de emergencia para cáncer de colon del lado derecho se asocian con mayores tasas de complicaciones y mortalidad en comparación con la cirugía electiva. Un enfoque de puente a la cirugia podría reducir estos riesgos al convertir los casos de urgencia en procedimientos electivos. Se necesitan más investigaciones para validar estos hallazgos. *(Traducción--Ingrid Melo)*

KEY WORDS: Bridge to surgery; Elective resection; Emergency surgery; Propensity score matching; Right-sided colon cancer; Short-term outcomes.

Approximately 30% of all colorectal cancers present as emergencies, most commonly due to acute colonic obstruction.[1] Historically, emergency resection has been the criterion standard for treating obstructive left-sided colon cancer. However, during the past decade, the treatment algorithm for patients with acute left-sided colonic obstruction has shifted, with an increasing number of patients now managed through a bridge-to-surgery (BTS) approach.[1]

This shift is not yet evident in patients presenting with an acute right-sided obstruction, where emergency resection remains the treatment of choice. This is likely due to past studies reporting similar mortality rates after elective versus emergency resection in these patients.[2] In addition, studies have shown that anastomotic leakage rates after right hemicolectomy are significantly lower compared to left-sided resections (1%–2% vs 5%–6%).[3] These findings have led to an international consensus that (emergency) right hemicolectomy with the construction of a primary anastomosis is safe, and therefore, a BTS approach has no added value.

Indeed, Bakker et al[4] reported that a protective stoma is constructed in only 3.1% of patients undergoing an emergency right-sided colon resection versus 9% of paitnets undergoing emergency left-sided resection. Therefore, surgeons seem less likely to create a protective stoma after a right-sided versus a left-sided emergency resection.

However, more recent studies report higher anastomotic leakage rates after right-sided resections than previously thought. Rates of around 9%, which is similar to the anastomotic leakage rate after left-sided resections, appear to be more realistic.[4,5] In addition, Bakker et al[6] found the mortality rate after emergency right-sided resection to be significantly higher compared to emergency left-sided resections (4.7% vs 3.5%). The lower rate of deviating stoma construction, in combination with an underestimated anastomotic leakage rate, might contribute to these numbers.[7,8] In fact, mortality has been reported to be up to 2 times higher after anastomotic leakage for right-sided anastomoses compared to left-sided anastomoses.[4,8]

If mortality and anastomotic leakage rates are, in fact, higher than previously thought for patients undergoing emergency right-sided resection, these patients might also benefit from a BTS approach.[9,10] This approach, in which a decompressing stent is placed or a deviating stoma is constructed, has seen a rise in popularity for left-sided obstructions, with most guidelines now recommending it for all patients presenting with left-sided obstructive colon carcinoma.[11,12] Although several studies have now indicated that a BTS approach might also lead to favorable outcomes in patients with a right-sided obstruction, it has yet to see a rise in popularity.[13,14] The hesitance to implement this treatment approach might be due to the previously stated developed consensus on right hemicolectomy being a relatively safe procedure, including in the emergency setting.

Therefore, the aim of the present study is to determine whether mortality, complication, and specifically anastomotic leakage rates after emergency resection for right-sided colon cancer are higher than resection in an elective setting.

MATERIALS AND METHODS

Study Design and Data Procurement

This nationwide, population-based cohort study used data from the Dutch ColoRectal Audit (DCRA). It is mandatory for all Dutch hospitals to prospectively record all patients who undergo a colorectal resection in this database.

Patient Selection

All patients who underwent a right-sided colonic resection between January 2009 and January 2020 were included. Right-sided tumors were defined as those located in the cecum, ascending colon, hepatic flexure, and transverse colon. Tumors in the splenic flexure or appendix were not included. The tumor location was entered into the DCRA database by the surgeon immediately postoperatively based on the intraoperative findings.

After inclusion, patients were categorized into 2 primary groups: those undergoing emergency surgery (defined as surgery within 72 hours) and those undergoing elective surgery. In addition, we identified a subgroup of patients who underwent BTS, which was compared to patients undergoing emergency resection in a separate analysis.

According to Dutch law, no informed consent or medical ethics approval was required, as patient and hospital details are registered anonymously. The study application was reviewed and approved by the scientific committee of the DCRA.

Outcome Parameters

Patients undergoing either elective or emergency surgery were compared on several baseline and surgical characteristics: age, sex, BMI, ASA classification, comorbidities, and TNM stage.

The primary outcome of this study was anastomotic leakage rate, which can only be calculated for patients in whom a primary anastomosis was constructed. The presence of anastomotic leakage was determined on the basis of CT findings, as assessed by an abdominal radiologist and the surgeon. All patients with a CT-confirmed anastomotic leakage were registered as such in the DCRA database, regardless of whether a reintervention was performed.

Secondary outcomes were 90-day complications, mortality, whether a stoma was constructed (if so, what type and location), reintervention, type of resection ([extended] right hemicolectomy or (sub)total colectomy), and length of hospital stay.

Complications were divided into 2 categories: surgical and general. Surgical complications included abscess, bleeding, bowel perforation, fascial dehiscence, ileus, anastomotic leakage, ureter/bladder leakage, and wound infection. Overall complications included surgical complications as well as all other medical complications, such as pulmonary, thromboembolic, infectious, cardiac, and neurological complications.

Statistical Analysis

Using 1:1 propensity score matching, 2 groups of equal size were formed. All patients who were not matched were excluded. Propensity score matching was performed using a caliper of 0.3. The variables used for matching were sex, age, BMI, tumor location, ASA classification, T4 tumor stage, metastasis at diagnosis, and year of surgery. Differences between treatment groups were expressed in standardized mean difference (SMD), with an SMD of 0.1 considered negligible, indicating appropriate matching. Missing data for the propensity score were imputed using multiple imputations.

Categorical or binary outcomes were presented as numbers with percentages and continuous outcomes were presented as either means with SDs or medians with interquartile ranges, depending on the distribution. Comparisons between categorical or binary variables were executed using the χ^2 test. Comparisons between continuous variables were made using the independent Student *t* test or the Mann-Whitney *U* test, depending on how data were distributed.

Statistical analysis of matched patients was performed using a generalized linear model; a p value of <0.05 was considered statistically significant. All statistical analyses were performed using R statistics version 2021.09.01.

In addition, a subgroup analysis was performed, matching BTS patients 1:4 with those undergoing emergency resection, using the same propensity score–matching principles as in the primary analysis.

Finally, in another subgroup analysis, we compared the outcomes of patients undergoing BTS to those undergoing elective surgery after 1:1 matching.

RESULTS

Patient Selection

A flow chart of patient selection is shown in Figure 1. In total, 37,690 patients with right-sided colon carcinoma were included from the DCRA database. Of these, 586 patients were excluded because of tumors in the left-sided colon or the appendix and 27 patients were excluded because of an unknown surgical setting (elective vs emergency). Finally, 226 patients were excluded because they underwent a BTS approach. All patients had histologically proven malignant disease, with the majority of patients presenting with an adenocarcinoma (85%). Therefore, the final study cohort consisted of 36,851 patients, with 31,700 undergoing elective surgery and 5151 undergoing emergency surgery. After 1:1 propensity score matching, a total of 5056 patients in each group were included in the analysis.

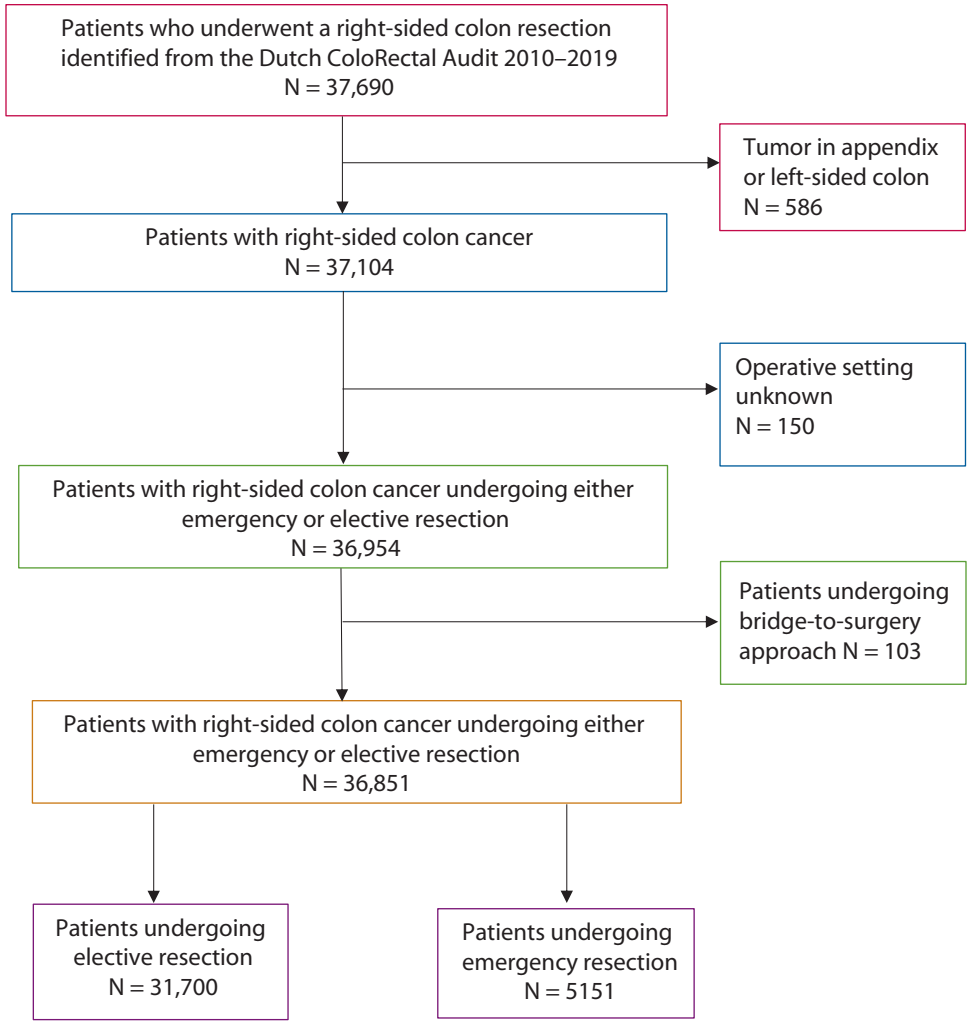

FIGURE 1. Flow chart illustrating the inclusion process of patients from the Dutch Colorectal Audit (2010–2019). Patients were excluded if they had tumors in the appendix or left-sided colon, if the operative setting was unknown, and if they did not undergo emergency or elective resections.

Baseline

Baseline comparison before and after propensity score matching is displayed in Table 1. Before propensity score matching, patients in the emergency resection group more often had an ASA classification of IV (6.3% vs 1.7%, SMD 0.320), a tumor located in the transverse colon (19.7% vs 14.2%, SMD 0.201), a T4 tumor (37.1% vs 14.3%, SMD 0.534), and a metastasis on diagnosis (23.8% vs 7.7%, SMD 0.455). Moreover, the number of emergency resections decreased over time, whereas the number of elective resections increased (Table 1).

All differences between the variables were less than 0.1 SMD after propensity score matching, indicating successful matching.

Primary Outcomes

All outcomes per treatment group are displayed in Table 2. A primary anastomosis was constructed significantly more often in the elective group (4816/5056; 95.3%) compared to the emergency resection group (4144/5056; 82.0%). These patients were included in assessing our primary outcome measure anastomotic leakage rate, as the other patients did not have an anastomosis. In these patients, anastomotic leakage rate did not differ between treatment groups (6.3% vs 5.6%, $p = 0.332$). However, as primary anastomosis construction was 13% lower in the emergency resection group, significantly fewer patients were at risk for developing an anastomotic leakage.

Perioperative Outcomes

In the matched cohort, the elective group had a significantly higher proportion of laparoscopic approaches compared to the emergency group (56.0% vs 19.4%, $p < 0.001$). No significant difference in the number of patients requiring a (sub)total colectomy was found (2.1% vs 1.7%, $p = 0.177$; Table 2).

Primary anastomoses were constructed significantly more often in the elective resection group than in the

TABLE 1. Baseline comparison of patients undergoing right-sided colon resection before and after PS matching

	Before PS matching			*After PS matching*		
Characteristics	*Elective (N = 31,700)*	*Emergency (N = 5151)*	*SMD*	*Elective (N = 5056)*	*Emergency (N = 5056)*	*SMD*
Male, n (%)	14,904 (47.0)	2449 (47.5)	0.011	2441 (48.3)	2401 (47.5)	0.025
Age, y, mean (SD)	71.94 (10.29)	71.74 (12.13)	0.018	71.83 (10.94)	71.80 (12.12)	0.003
BMI, mean (SD)	26.42 (4.62)	25.04 (4.54)	0.302	25.04 (4.12)	25.08 (4.54)	0.010
Tumor location, n (%)			0.201			0.011
Coecum	11,496 (36.3)	1927 (37.4)		1903 (37.6)	1893 (37.4)	
Ascending colon	12,037 (38.0)	1533 (29.8)		1499 (29.6)	1524 (30.1)	
Hepatic flexure	3653 (11.5)	676 (13.1)		657 (13.0)	656 (13.0)	
Transverse colon	4514 (14.2)	1015 (19.7)		997 (19.7)	983 (19.4)	
ASA classification, n (%)			0.320			0.092
I	4174 (13.2)	657 (12.8)		663 (13.1)	657 (13.0)	
II	18,278 (57.7)	2387 (46.3)		2419 (47.8)	2384 (47.2)	
III	8699 (27.4)	1756 (34.1)		1728 (34.2)	1727 (34.2)	
IV	524 (1.7)	320 (6.3)		242 (4.8)	257 (5.1)	
Missing	25 (0.1)	31 (0.6)		4 (0.1)	31 (0.6)	
pT4, n (%)	4533 (14.3)	1913 (37.1)	0.534	1818 (36.0)	1804 (35.7)	0.053
Missing	25 (0.1)	49 (1.0)		76 (1.5)	47 (0.9)	
cM stage, n (%)			0.455			0.034
0	23,604 (74.5)	3109 (60.4)		3180 (62.9)	3097 (61.3)	
1	2446 (7.7)	1228 (23.8)		1108 (21.9)	1162 (23.0)	
Missing	5650 (17.8)	814 (15.8)		768 (15.2)	797 (15.8)	
Year of resection			0.260			0.035
2010	2633 (8.3)	559 (10.9)		552 (10.9)	552 (10.9)	
2011	2616 (8.3)	626 (12.2)		613 (12.1)	620 (12.3)	
2012	2990 (9.4)	638 (12.4)		633 (12.5)	631 (12.5)	
2013	2878 (9.1)	573 (11.1)		611 (12.1)	559 (11.1)	
2014	3331 (10.5)	551 (10.7)		528 (10.4)	543 (10.7)	
2015	3499 (11.0)	524 (10.2)		497 (9.8)	514 (10.2)	
2016	3692 (11.6)	476 (9.2)		471 (9.3)	471 (9.3)	
2017	3457 (10.9)	452 (8.8)		432 (8.5)	433 (8.6)	
2018	3313 (10.5)	375 (7.3)		364 (7.2)	363(7.2)	
2019	3291 (10.4)	377 (7.3)		355 (7.0)	370 (7.3)	

PS = propensity score; SMD = standardized mean difference.

emergency group (95.3% vs 82.0%, $p < 0.001$). When a primary anastomosis was constructed, patients in the emergency surgery group more often had a deviating stoma constructed (3.5 vs 1.1%, $p < 0.001$).

The overall stoma rate was also significantly higher in patients undergoing emergency resection compared to those undergoing elective resection (19.3% vs 4.5%, $p < 0.001$). The distribution of stoma types varied considerably between groups; patients who underwent emergency resection were more likely to receive an end ileostomy (66.2% vs 52.8%, $p < 0.001$; Table 2).

Postoperative Outcomes

The 90-day mortality rate differed significantly, with a rate of 9.4% in the emergency resection group compared to 4.2% in the elective resection group ($p < 0.001$). In line with this finding, the overall 90-day complication rate was nearly 12% higher in the emergency resection group compared to the elective resection group (41.7% vs 33.0%, $p < 0.001$). Surgical complications were also significantly higher (20.6% vs 17.4%, $p < 0.001$), although there was no difference in the number of reinterventions (10.4% vs 9.6%, $p = 0.197$).

The 90-day readmission rate (6.6% vs 7.6%, $p = 0.155$) did not differ significantly between the elective surgery group and the emergency resection group. In addition, the radical resection rate was not significantly different between groups (92.1% vs 91.5%, $p = 0.358$).

Subgroup Analysis: BTS vs Emergency Resection

Baseline characteristics for the BTS and emergency resection groups, both before and after propensity score matching, are displayed in Table 3. Before matching, patients in the BTS group were slightly younger on average (70.1 vs 71.7 years, SMD 0.134) and had a higher proportion of tumors located in the transverse colon (47.6% vs 19.7%, SMD 0.672). Other baseline differences, such as ASA classification and metastatic stage, were also observed. After matching, all baseline differences were minimized, with SMDs less than 0.1, indicating successful matching.

TABLE 2. Surgical characteristics and outcomes after right-sided colon resection

Outcomes	*Elective (N = 5056), n (%)*	*Emergency (N = 5056), n (%)*	*p*
Primary outcome			
Anastomotic leakage	272/4816 (5.6)	262/4144 (6.3)	0.332
Missing	2	0	
Perioperative outcomes			
Laparoscopic approach	2830 (56.0)	981 (19.4)	<0.001
Need for (sub)total colectomy	105 (2.1)	85 (1.7)	0.177
Missing	4 (0.1)	8 (0.2)	
Primary anastomosis	4816 (95.3)	4144 (82.0)	<0.001
With deviating stoma	55/4816 (1.1)	164/4144 (3.5)	<0.001
Missing	38 (0.8)	37 (0.7)	
Overall stoma rate	231 (4.5)	978 (19.3)	<0.001
Type of stoma[a]			<0.001
End ileostomy	122/231 (52.8)	647/978 (66.2)	
End colostomy	51/231 (22.1)	163/978 (16.7)	
Deviating ileostomy	47/231 (20.3)	146/978 (14.9)	
Deviating colostomy	8/231 (3.4)	18/978 (1.8)	
Stoma, type unknown	3/231 (1.3)	4/978 (0.4)	
Postoperative outcomes			
90-d mortality	210 (4.2)	476 (9.4)	<0.001
Missing	5 (0.1)	7 (0.1)	
90-d complication	1668 (33.0)	2106 (41.7)	<0.001
Surgical complication	880 (17.4)	1043 (20.6)	<0.001
Reintervention rate	487 (9.6)	527 (10.4)	0.197
90-d readmission	336 (6.6)	386 (7.6)	0.155
Missing	6 (0.1)	5 (0.1)	
Radical resection	4655 (92.1)	4627 (91.5)	0.358

[a]Stoma types are presented as a percentage of the total number of stomas constructed.

Anastomotic leakage rates did not differ significantly between the BTS and emergency resection groups (6.8% vs 5.8%, $p = 0.889$), as shown in Table 4.

The BTS group had a significantly higher rate of laparoscopic approaches (43.7% vs 27.2%, $p < 0.001$). Primary anastomosis was also more frequently constructed in BTS patients (87.4% vs 75.0%, $p = 0.008$), and the overall stoma rate was significantly lower in the BTS group (7.8% vs 27.2%, $p < 0.001$). Conversely, the need for a (sub)total colectomy was significantly higher in the BTS group (6.8% vs 1.9%, $p = 0.022$).

The 90-day mortality rate was significantly lower in the BTS group (3.9% vs 11.7%, $p = 0.031$). Although the overall 90-day complication rate was lower in the BTS group (38.8% vs 46.6%), this difference did not reach statistical significance ($p = 0.191$). Rates of surgical complications, reinterventions, and readmissions within 90 days were similar between the groups. In addition, the rate of radical resection did not differ significantly (5.8% vs 6.1%, $p > 0.99$).

Subgroup Analysis: BTS vs Elective Surgery

Baseline characteristics of the BTS and elective resection groups, both before and after propensity score matching, are presented in Table 5. Before 1:1 matching, significant differences were observed in all baseline characteristics except for sex. After matching, the SMD was substantially reduced for all characteristics except sex, indicating successful matching.

Surgical characteristics and postoperative outcomes for the BTS and elective resection groups are summarized in Table 6. Patients in the BTS group underwent laparoscopic surgery significantly less often compared to those in the elective surgery group (43.7% vs 72.8%, $p = 0.009$). No significant differences were observed for other surgical characteristics or postoperative outcomes.

DISCUSSION

Although the anastomotic leakage rates after emergency surgery were not significantly higher compared to those after elective surgery (6.3% vs 5.6%, $p = 0.332$), patients undergoing emergency resection faced a significantly higher risk of surgical and overall complications (20.6% vs 17.4%, $p < 0.001$, and 41.7% vs 33.0%, $p < 0.001$, respectively) and had double the mortality risk (9.4% vs 4.2%, $p < 0.001$). Furthermore, when comparing outcomes between BTS and emergency surgery patients in a subanalysis, those undergoing emergency surgery experienced worse outcomes across several measures: the mortality rate was nearly 3 times higher for emergency surgery patients than for BTS patients (11.7% vs 3.9%, $p = 0.031$), and they were

TABLE 3. Baseline comparison of patients undergoing right-sided colon resection: emergency vs BTS before and after PS matching

	Before PS matching			*After PS matching*		
Characteristics	*Emergency (N = 5151)*	*BTS (N = 103)*	*SMD*	*Emergency (N = 412)*	*BTS (N = 103)*	*SMD*
Male, n (%)	2449 (47.5)	52 (50.5)	0.059	204 (49.5)	52 (50.5)	0.019
Age, y, mean (SD)	71.74 (12.13)	70.09 (12.52)	0.134	69.79 (12.09)	70.09 (12.52)	0.024
BMI, mean (SD)	25.02 (4.51)	24.98 (4.66)	0.134	25.17 (4.71)	24.98 (4.84)	0.041
Tumor location, n (%)			0.672			0.181
Coecum	1927 (37.4)	17 (16.5)		61 (14.8)	17 (16.5)	
Ascending colon	1533 (29.8)	26 (25.2)		117 (28.4)	26 (25.2)	
Hepatic flexure	676 (13.1)	11 (10.7)		64 (15.5)	11 (10.7)	
Transverse colon	1015 (19.7)	49 (47.6)		170 (41.3)	49 (47.6)	
ASA classification, n (%)			0.325			<0.001
I	660 (12.8)	6 (5.8)		24 (5.8)	6 (5.8)	
II	2401 (46.6)	45 (43.7)		180 (43.7)	45 (43.7)	
III	1767 (34.3)	48 (46.6)		192 (46.6)	48 (46.6)	
IV	323 (6.3)	4 (3.9)		16 (3.9)	4 (3.9)	
pT4, n (%)	1911 (37.1)	35 (34.0)	0.065	139 (33.7)	35 (34.0)	0.005
cM stage, n (%)			0.135	270 (65.5)	69 (67.0)	0.031
0	3769 (73.2)	69 (67.0)		142 (34.5)	34 (33.0)	
1	1382 (26.8)	34 (33.0)				
Year of resection			1.649			0.863
2010	559 (10.9)	7 (6.8)		12 (2.9)	7 (6.8)	
2011	626 (12.2)	6 (5.8)		13 (3.2)	6 (5.8)	
2012	638 (12.4)	4 (3.9)		11 (2.7)	4 (3.9)	
2013	573 (11.1)	1 (1.0)		11 (2.7)	1 (1.0)	
2014	551 (10.7)	4 (3.9)		24 (5.8)	4 (3.9)	
2015	524 (10.2)	0		27 (6.6)	0	
2016	476 (9.2)	4 (3.9)		32 (7.8)	4 (3.9)	
2017	452 (8.8)	0		59 (14.3)	0	
2018	375 (7.3)	37 (35.9)		78 (18.9)	37 (35.9)	
2019	377 (7.3)	40 (38.8)		145 (35.2)	40 (38.8)	

BTS = bridge to surgery; PS = propensity score; SMD = standardized mean difference.

significantly more likely to undergo open surgery (72.8% vs 56.3%, $p < 0.001$). Emergency surgery patients were also more likely to end up with a stoma after definitive resection (27.2% vs 7.8%, $p < 0.001$).

Although anastomotic leakage rates were comparable between patients undergoing emergency and elective surgery, the number of primary anastomoses constructed was significantly lower in the emergency surgery group (82.0% vs 95.3%, $p < 0.001$). This suggests that anastomoses were not created in patients most at risk for anastomotic leakage (eg, older patients with more comorbidities), potentially leading to an underestimation of the true leakage risk. Moreover, whereas no significant differences were found in the number of anastomotic leakages, the leakage rates of 6.3% and 5.6% in the current study are notably higher than in several older studies, which reported rates <2%.[3,15] Therefore, these findings could imply that the construction of a primary anastomosis is not as safe as previously thought in right-sided (emergency) resections.

The increased morbidity and mortality risks in the emergency resection group are striking and might be explained by multiple reasons. First, although we matched our patients according to baseline characteristics, patients undergoing emergency surgery are likely in worse preoperative condition compared to patients undergoing elective surgery due to dehydration and malnutrition after a prolonged period of inadequate intake.[16,17] A worse preoperative condition predicts a worse postoperative condition of the patient, giving the patient a higher risk of developing complications.[18,19]

In addition, emergency surgery is more often performed open, which results in longer hospital admissions and is also known to increase the risk of falling and developing infectious complications.[20,21] So although emergency surgery with the construction of a primary anastomosis is safe with regard to anastomotic leakage risk, emergency surgery itself is not.

Of course, emergency surgery can sometimes not be avoided, such as when acute bowel ischemia or a perforation is present. However, the findings of the current study imply that, when possible, an emergency resection should be avoided. Indeed, for patients presenting with an acute right-sided obstruction in the emergency setting, a valid alternative is available in the form of a BTS approach. This approach involves a deliberate delay in performing definitive tumor resection by using techniques such as constructing a deviating stoma or placing a colonic stent. The underlying rationale behind this implication is 2-fold.

TABLE 4. Surgical characteristics and outcomes after right-sided colon resection: emergency vs BTS

Outcomes	*Emergency (N = 412), n (%)*	*BTS (N = 103), n (%)*	*p*
Primary outcome			
Anastomotic leakage	24 (5.8)	7 (6.8)	0.889
Perioperative outcomes			
Stent as BTS	NA	41 (39.8)	NA
Stoma as BTS	NA	62 (60.2)	
Laparoscopic approach	112 (27.2)	45 (43.7)	<0.001
Need for (sub)total colectomy	8 (1.9)	7 (6.8)	0.022
Primary anastomosis	309 (75.0)	90 (87.4)	0.008
With deviating stoma	15/309 (4.9)	1/90 (1.1)	0.198
Missing	2	1	
Overall stoma rate	112 (27.2)	8 (7.8)	<0.001
Stoma type			0.940
End ileostomy	60/112 (53.6)	4/8 (50.0)	
End colostomy	37/112 (33.0)	3/8 (37.5)	
Deviating ileostomy	4/112 (3.6)	1 (12.5)	
Deviating colostomy	11/112 (9.8)	0	
Postoperative outcomes			
90-d mortality	48 (11.7)	4 (3.9)	0.031
90-d complication	192 (46.6)	40 (38.8)	0.191
Surgical complication	111 (26.9)	24 (23.3)	0.531
Reintervention rate	58 (14.1)	14 (13.6)	>0.99
90-d readmission	61 (14.8)	18 (17.5)	0.617
Missing	2	0	
Radical resection	25 (6.1)	6 (5.8)	>0.99

BTS = bridge to surgery; NA = not applicable.

First, by postponing the definitive resection, decompression of the colon can be achieved, resulting in improved tissue quality and facilitating technically easier resection. Second, it allows for prehabilitation, a process aimed at optimizing patients' nutritional status and physical condition. Here, the emergency resection is converted to an elective procedure with the hypothesis that this could significantly lower morbidity and mortality risk. The findings from our subgroup analysis partially support this hypothesis, showing a notably lower mortality rate in patients undergoing BTS compared to those undergoing emergency resection. However, anastomotic leakage, 90-day surgical and overall complication rates, and reintervention rates did not differ significantly. Therefore, this disparity in mortality could be attributed to the poorer preoperative condition of patients undergoing emergency resection, who were likely experiencing dehydration, malnutrition, and other factors. Unlike BTS patients, these individuals did not have the benefit of a bridging period to stabilize before surgery, which may have led to the observed increase in postoperative mortality despite similar complication rates. Another possible explanation is that, as reported, the overall complication rate is, in fact, higher for patients undergoing emergency resection; however, this difference likely did not reach statistical significance due to the smaller sample size in this subanalysis. In addition, our analysis comparing BTS patients with those undergoing elective surgery showed no significant differences in postoperative outcomes between these groups. This finding further supports the notion that a BTS approach can optimize outcomes for patients initially presenting in an emergency setting, effectively improving results to a level comparable to those of elective surgery.

For left-sided colonic obstructions, this hypothesis has been more robustly validated, and a BTS approach is previously regarded as the criterion standard.[12,22] For patients presenting with an emergency right-sided obstruction, several other studies that have investigated this were subsequently included in a systematic review by Boeding et al.[23] The findings of the reviewed articles suggest that patients undergoing a BTS approach experience lower mortality rates, reduced occurrences of anastomotic leakages and other complications, and a decreased need for stoma constructions, which are in line with the findings in our study. However, it should be noted that the included studies were retrospective in nature, the studies had a limited number of patients undergoing a BTS approach, and none of the studies included patients who received a deviating stoma as BTS. Nevertheless, this systematic review also emphasizes a high mortality rate in patients undergoing emergency resection (7.2%).

Furthermore, studies comparing BTS to emergency resection in left-sided obstructive colon cancer also report an increased rate of surgeries conducted laparoscopically in patients undergoing BTS.[24–26] This implies that a BTS approach could improve the strikingly low laparoscopic surgery rate reported in this study for patients undergoing emergency surgery for right-sided obstructions (19.3%).

TABLE 5. Baseline comparison of patients undergoing right-sided colon resection: elective vs BTS before and after PS matching

	Before PS matching			*After PS matching*		
Characteristics	*Elective (N = 31 700)*	*BTS (N = 103)*	*SMD*	*Elective (N = 103)*	*BTS (N = 103)*	*SMD*
Male, n (%)	14,904 (47.0)	52 (50.5)	0.069	63 (61.2)	52 (50.5)	0.216
Age, y, mean (SD)	71.94 (10.29)	70.09 (12.52)	0.154	69.72 (11.75)	70.09 (12.52)	0.036
BMI, mean (SD)	26.42 (4.62)	24.98 (4.66)	0.294	24.95 (4.83)	24.98 (4.84)	0.033
Tumor location, n (%)			0.781			0.060
Coecum	11,496 (36.3)	17 (16.5)		17 (16.5)	17 (16.5)	
Ascending colon	12,037 (38.0)	26 (25.2)		26 (25.2)	26 (25.2)	
Hepatic flexure	3653 (11.5)	11 (10.7)		15 (14.6)	11 (10.7)	
Transverse colon	4514 (14.2)	49 (47.6)		45 (43.7)	49 (47.6)	
ASA classification, n (%)			0.491			0.113
I	4174 (13.2)	6 (5.8)		4 (3.9)	6 (5.8)	
II	18,278 (57.7)	45 (43.7)		48 (46.6)	45 (43.7)	
III	8699 (27.4)	48 (46.6)		45 (43.7)	48 (46.6)	
IV	524 (1.7)	4 (3.9)		6 (5.8)	4 (3.9)	
Missing	25 (0.1)	0				
pT4, n (%)	4533 (14.3)	35 (34.0)	0.451	36 (35.0)	35 (34.0)	0.041
Missing	25 (0.1)	0				
cM stage, n (%)			0.464			0.118
0	23,604 (74.5)	69 (67.0)		83 (80.6)	69 (67.0)	
1	2446 (7.7)	34 (33.0)		20 (19.4)	34 (33.0)	
Missing	5650 (17.8)	0				
Year of resection			1.523			0.297
2010	2633 (8.3)	7 (6.8)		7 (6.8)	7 (6.8)	
2011	2616 (8.3)	6 (5.8)		6 (5.8)	6 (5.8)	
2012	2990 (9.4)	4 (3.9)		7 (6.8)	4 (3.9)	
2013	2878 (9.1)	1 (1.0)		0 (0.0)	1 (1.0)	
2014	3331 (10.5)	4 (3.9)		4 (3.9)	4 (3.9)	
2015	3499 (11.0)	0		0	0	
2016	3692 (11.6)	4 (3.9)		0	4 (3.9)	
2017	3457 (10.9)	0		0	0	
2018	3313 (10.5)	37 (35.9)		42 (40.8)	37 (35.9)	
2019	3291 (10.4)	40 (38.8)		37 (35.9)	40 (38.8)	

BTS = bridge to surgery; PS = propensity score; SMD = standardized mean difference.

Our subgroup analysis further supports this, showing that patients undergoing BTS are much more likely to have laparoscopic surgery compared to those undergoing emergency resection.

The same can be said about the construction of primary anastomoses, which, as reported earlier, is significantly lower for patients undergoing emergency surgery compared to those undergoing BTS (75.0% vs 87.4%, $p < 0.008$). Multiple other studies have also reported that the construction of a primary anastomosis is performed significantly more often after BTS compared to emergency surgery, further confirming the validity of this finding.[26,27]

Finally, a novel approach gaining traction in the management of right-sided obstructive colon cancer is the preoptimization protocol. This strategy involves delaying resection in favor of semielective surgery, facilitated by nasogastric decompression and parenteral nutrition for several days without the need for an additional intervention (such as a stent/stoma). The aim is to improve patient stability before surgery, ultimately reducing postoperative morbidity and mortality. Early results from this approach, as published by Boeding et al[28] in the *European Journal of Surgical Oncology*, indicate that it is a safe and effective method for managing these complex cases. This emerging strategy may offer another viable alternative to emergency surgery. This strategy is particularly relevant because, in some patients, creating a stoma as a BTS may be undesirable or stent placement may not be feasible due to the proximal location of the tumor, as evidenced by the higher proportion of transverse colon tumors in the BTS group.

A strong point of this study was the fact that we used a national prospective database in which all Dutch hospitals are required to register all their patients. By matching patients based on the propensity score, most possible confounders were accounted for, thereby reducing the risk of bias.[29]

Some limitations, however, must be discussed. First, the DCRA database, being a national audit, has some missing data, and due to the anonymization of the registered patients, it was impossible to retrieve these data. However, missing data were minimal, and we further accounted for this limitation by use of multiple imputation.[30] Another limitation is that, although we used a propensity score–matching model, certain selection biases

TABLE 6. Surgical characteristics and outcomes after right-sided colon resection: elective vs BTS

Outcomes	*Elective (N = 103), n (%)*	*BTS (N = 103), n (%)*	*p*
Primary outcome			
Anastomotic leakage	5 (4.9)	7 (6.8)	0.766
Stent as BTS	NA	41 (39.8)	NA
Stoma as BTS	NA	62 (60.2)	
Laparoscopic approach	75 (72.8)	45 (43.7)	0.009
Need for (sub)total colectomy	3 (2.9)	7 (6.8)	0.331
Primary anastomosis	95 (92.2)	90 (87.4)	0.357
With deviating stoma	3/95 (3.2)	1/90 (1.1)	
Missing	0	1	
Overall stoma rate	7 (6.8)	8 (7.8)	>0.99
Stoma type			0.521
End ileostomy	1/7 (14.3)	4/8 (50.0)	
End colostomy	3/7 (42.9)	3/8 (37.5)	
Deviating ileostomy	2/7 (28.6)	1/8 (12.5)	
Deviating colostomy	1/7 (14.3)	0	
90-d mortality	5 (4.9)	4 (3.9)	>0.99
90-d complication	31 (30.1)	40 (38.8)	0.188
Surgical complication	20 (19.4)	24 (23.3)	0.610
Reintervention rate	14 (13.6)	14 (13.6)	>0.99
90-d readmission	12 (11.7)	18 (17.5)	0.323
Radical resection	101 (98.1)	97 (94.2)	0.679

BTS = bridge to surgery; NA = not applicable.

cannot be corrected because of unknown confounders. Variables such as nutritional status and physical condition are likely to influence postoperative outcomes but were not registered in the DCRA database. However, given the impossibility of randomization, we believe that using this model provides the most robust approach to conducting this comparison, mitigating the influence of unknown confounders to the greatest extent possible. Finally, despite using propensity score matching to compare 2 cohorts, we are aware that, before matching, the emergency surgery group encompasses more patients with a high ASA classification (III and IV) compared to the elective surgery group. This raises the possibility that our comparison might inadvertently pair less healthy patients from the elective group with relatively healthier patients from the emergency group. Consequently, this could lead to an overestimation of complications and mortality in the elective group and an underestimation of adverse outcomes in the emergency group. However, this limitation is inherent to propensity score–matching techniques. If present in this study, it would suggest that the difference in adverse events across the entire population may be even greater, which further emphasizes the risks associated with emergency resections.

CONCLUSIONS

Our study underlines the elevated risk associated with emergency resection for right-sided colon cancer, as evidenced by a higher rate of complications and mortality compared to elective resections. Implementing a BTS approach might improve outcomes for patients presenting in an emergency setting. However, further research is needed to validate its effectiveness and explore the optimal strategies for its application.

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