

ORIGINAL ARTICLE



Prospective evaluation of bowel function and quality of life after colon cancer surgery – is it time for routine screening for late sequelae?

Annette Boesen Bräuner^{a,b,c} , Nicolas Avellaneda^{d,e} , Peter Christensen^{b,c,e} , Asbjørn Mohr Drewes^{b,f,g} ,
Katrine Jøssing Emmertsen^{b,c,h} , Klaus Krogh^{b,i} , Søren Laurberg^{b,c} , Michael Bødker Lauritzen^{b,j} ,
Uffe Schou Løve^{a,c} , Ole Thorlacius-Ussing^{b,g,j}  and Therese Juul^{b,c,e} 

^aDepartment of Surgery, Regional Hospital Viborg, Viborg, Denmark; ^bDanish Cancer Society Centre for Research on Survivorship and Late Adverse Effects After Cancer in the Pelvic Organs, Aalborg, Denmark; ^cDepartment of Clinical Medicine, Aarhus University, Aarhus, Denmark; ^dGeneral Surgical Department, Centro de Educación Médica e Investigaciones Clínicas “Noberto Quirno” (CEMIC), Buenos Aires, Argentina; ^eDepartment of Surgery, Aarhus University Hospital, Aarhus, Denmark; ^fMech-Sense. Department of Gastroenterology and Hepatology, Aalborg University Hospital, Aalborg, Denmark; ^gDepartment of Clinical Medicine, Aalborg University, Aalborg, Denmark; ^hDepartment of Surgery, Regional Hospital Randers, Randers, Denmark; ⁱDepartment of Hepatology and Gastroenterology, Aarhus University Hospital, Aarhus, Denmark; ^jDepartment of Gastrointestinal Surgery, Aalborg University Hospital, Aalborg, Denmark

ABSTRACT

Aim: Bowel dysfunction after colon cancer (CC) surgery is widely neglected in current follow up programmes. This study explored changes in bowel function and quality of life (QoL) from three (3 m) to twelve months (12 m) after surgery in CC patients undergoing right- or left-sided colon resection (RightSCR/LeftSCR) and investigated differences between the two groups 12 m after surgery.

Method: CC patients undergoing surgical resection in 2018–2020 at five surgical departments were included in this population-based prospective cohort study. Included patients completed electronic surveys consisting of a collection of validated scores 3 m and 12 m after surgery.

Results: A total of 708 CC patients (423 RightSCR, 285 LeftSCR) were included. In RightSCR, no improvement was observed from 3 m to 12 m in most scores/items, on the contrary, symptom *worsening* in flatus- and faecal incontinence and urgency was observed ($p < 0.05$). Also, the proportion of patients rating their bowel function as very good/good decreased ($p < 0.05$) in this group.

In LeftSCR improvement was found in flatus and faecal incontinence, urgency and night-time defaecation ($p < 0.02$), while no improvement was observed in the remaining scores/items.

At 12 m, higher proportions of RightSCR than LeftSCR reported loose stools, incontinence and urgency (all $p < 0.001$), whereas LeftSCR more often reported hard stools and flatus incontinence ($p < 0.05$). Among all CC patients 18.3% reported bowel-related impairment of QoL at 12 m with no differences between the two groups.

Conclusion: From 3 m to 12 m no significant change was observed in the majority of bowel function and QoL scores/items, however, some symptoms *worsened* in RightSCR, while a few *improved* in LeftSCR. Bowel dysfunction and impaired QoL were still common in both groups at 12 m, although the symptom pattern differed between the groups. These findings call for a systematic screening for bowel dysfunction to ensure early treatment of symptoms.

ARTICLE HISTORY

Received 11 April 2023

Accepted 2 August 2023

KEYWORDS

Colon cancer; late sequelae; bowel dysfunction; quality of life; screening

Introduction

Colorectal cancer (CRC) is the third most common cancer worldwide and the second most common cause of cancer-related death [1]. Survival rates have increased significantly during the past decades [2,3], and a global trend towards an increasing number of young people being diagnosed with CRC has been observed [4–6]. These trends have produced a rising number of CRC survivors.

Whereas the continuously improving oncological outcomes after colon cancer (CC) treatment have been analysed extensively in prior publications [3,7,8], the long-term functional consequences of treatment have received less attention. Most studies of functionality following surgical CRC treatment have focused on rectal cancer (RC) patients because of a well-

documented high prevalence of late sequelae and impaired quality of life (QoL) in this patient group [9–15]. In contrast, functional results after surgical treatment of CC are still poorly documented in the literature. Most of the few previously published studies investigating late sequelae after CC are primarily cross-sectional, include < 100 patients, and often pool CRC patients, making it difficult to identify the specific problems experienced by the subgroup of CC patients [16]. However, three recent studies including large patient numbers [17–19] have demonstrated that a significant proportion of CC patients suffer from severe long-term bowel dysfunction and that the symptom pattern differs between patients undergoing right- and left-sided colon resection. Even so, the specific impact of surgery on CC patients' bowel function and QoL over time remains unclear and needs to be further investigated.

In this study, we hypothesised that CC patients' bowel function would improve spontaneously during the first year after surgery and that the symptoms still present at that time would differ between patients undergoing a right-sided colon resection (RightSCR) and a left-sided colon resection (LeftSCR).

Hence, the primary aim of the present study was to explore changes in bowel function and QoL from 3 months (3 m) to 12 months (12 m) after surgery in CC patients undergoing a RightSCR or a LeftSCR.

The secondary aim was to investigate differences in bowel function and QoL 12 m after surgery between these two groups of CC patients.

Methods

Data for the present study were extracted from the database of a large, ongoing, multicentre, population-based, prospective cohort study investigating late sequelae following CRC treatment *via* patient-reported outcome measures (PROMs). A detailed presentation of the study design has been published previously [20].

In- and exclusion criteria

Eligible for the present study were CC patients older than 18 years who underwent resectional surgery at the surgical departments at Aarhus, Viborg, Randers, Aalborg, and Hjoerring hospitals, which cover 23% of all CC cases in Denmark [21]. Patients were included if they had a right-sided hemicolectomy, an extended right-sided hemicolectomy or a left-sided hemicolectomy which includes resection of the sigmoid colon according to Danish guidelines. Patients undergoing other types of colonic cancer surgery were excluded from the analyses. Patients with advanced tumours, defined as tumour growth beyond the mesocolic fascia, histopathological pT4 tumours with invasion of adjacent structures, or peritoneal carcinomatosis were also excluded, as these patients were enrolled in another scientific study with similar aims. Further exclusion criteria were cognitive impairment, linguistic limitations, participation in another scientific study running counter to the present one, or not living in the region of one of the participating centres. Also, patients were excluded if the project nurse considered it unethical to approach the patients due to late-stage disease/palliative treatment, severe comorbidity, or other major physical/mental limitations.

Patients who completed PROMs at both 3 and 12 months after surgery were included. We excluded patients from the analyses if the survey was completed outside the accepted time range, defined as less than two months or more than seven months after surgery for the 3 m survey, and less than ten months or more than 16 months after surgery for the 12 m-survey.

Data and data sources

Electronic PROMs were distributed *via* 'e-Boks', a secure public electronic mail system provided by the Danish government

[22]. A paper version of the PROMs was distributed by ordinary mail to patients not capable of/willing to respond electronically. Clinical variables were extracted from the national clinical database of the Danish Colorectal Cancer Group (DCCG) [23]. In this database, > 95% of all patients with a first-time CRC are registered, and the database has proven to provide highly valid and complete data [24]. Information on post-operative chemotherapy was extracted from the patient charts, whereas presence of a stoma was reported by the patients.

The PROM collection consisted of the Bristol Stool Form Scale [25,26], the Patient Assessment of Constipation Symptoms (PAC-SYM) questionnaire [27,28], the Low Anterior Resection Syndrome (LARS) score [29], the St. Marks Faecal Incontinence/Vaizey score [30], the EuroQoL 5 Dimensions-5 levels (EQ5D-5L) score [31–33]. Furthermore, five *ad hoc* items not covered by the above-mentioned validated scores were added. All validated scores and *ad hoc* items are presented in detail in Appendix A (Table A1).

Statistical analyses

Type of surgery was dichotomised into two groups: RightSCR (right-sided hemicolectomies and extended right-sided hemicolectomies) and LeftSCR (left-sided hemicolectomies and sigmoid resections).

Clinical and sociodemographic characteristics of the included patients were presented separately for RightSCR and LeftSCR, with numbers (n) (%) for categorical variables and mean (Standard Deviation (SD)) for continuous variables.

Bowel function and QoL at 3 m and 12 m were presented separately for RightSCR and LeftSCR with *n* (%) for categorical variables and median (interquartile range (IQR)) for continuous variables. Differences between the two time points within the groups were tested using McNemar's test or the Wilcoxon Signed Rank Test, depending on the type and distribution of the variables.

Differences between RightSCR and LeftSCR at 12 m were tested using the Wilcoxon Rank Sum Test and Fisher's Exact test, as appropriate.

For categorical variables with three response options, each response option was tested against the total of the two other response options.

Differences in means and proportions were presented with a 95% confidence interval (CI).

The distribution of PAC SYM variables was right-skewed and dominated by zeros. Therefore, the median and IQR were reported in Tables 2 and 3. We reported the mean change of PAC SYM from 3 m to 12 m in Table 2 along with their 95% CIs, which were calculated using the bootstrap method. The p-values were calculated using the sign-rank test. For comparison of RightSCR and LeftSCR of the PAC SYM variables, we used quantile regression for medians and differences between the medians and their 95% CI along with the p-value were reported.

Due to the high number of included variables, only symptoms showing statistically significant differences are presented in the text, while all results are shown in tables.

A multivariate logistic regression analysis was conducted to investigate the association of selected variables with the *ad hoc* item ‘Overall, how much does your bowel function affect your quality of life?’ at 12 m. For this purpose, the response options were dichotomised into ‘not at all/a little’ versus ‘somewhat/very much’. Age, gender, body mass index, type of surgery, surgical approach, chemotherapy, pathological Union for International Cancer Control (pUICC) stage, WHO performance status, Charlson comorbidity index and presence of a stoma at 12 m were included as independent/explanatory variables. Since bowel function is a part of the binary outcome of the regression analyses (‘How much does bowel function affect your QoL’) bowel function was not included among the explanatory variables.

Ethical approvals

Participants signed an informed consent form after receiving information about the study. This survey-based study did not require consent from the National Committee on Health Research Ethics in Denmark. It was registered with the Danish Data Protection Agency as Health Science Research of the Central Denmark Region.

Results

In- and exclusions

A flow chart of included and excluded patients is presented in Figure 1.

Among 1,168 CC patients undergoing a RightSCR or a LeftSCR at the participating centres during the inclusion period, 184 were excluded for reasons shown in Figure 1.

Among the invited 984 CC patients, 766 accepted to participate and completed the survey at 3 m, corresponding to an inclusion rate of 77.8%. After having completed the 3 m survey, another 58 patients were excluded (Figure 1). Hence, a total of 708 patients of the initially eligible patients were included in the final analyses (72.0%).

Patient characteristics

Table 1 shows the clinical and sociodemographic characteristics of the 708 patients, among whom 423 (59.7%) had undergone a RightSCR and 285 (40.3%) a LeftSCR.

The median (IQR) time between surgery and completion of the 3 m survey was 105 (97–119) days; for the 12 m survey, 373 (366–384) days.

Change in bowel function and QoL from 3 m to 12 m

A total of 46 patients with a stoma at 3 m and/or 12 m were excluded from these paired analyses. The results for the remaining 662 patients are presented in Table 2.

RightSCR: no change or symptom worsening

In RightSCR, no changes were observed in most scores/items from 3 m to 12 m. However, patients having undergone RightSCR experienced a statistically significant symptom worsening from 3 m to 12 m in the rectal subscale of the PAC-SYM (mean diff (95% CI) 0.07 (0.02;0.13), $p = 0.01$). However, as the minimal important difference (MID) for PAC-SYM has previously been established to be 0.6 points [28] the size of the difference is considered clinically irrelevant.

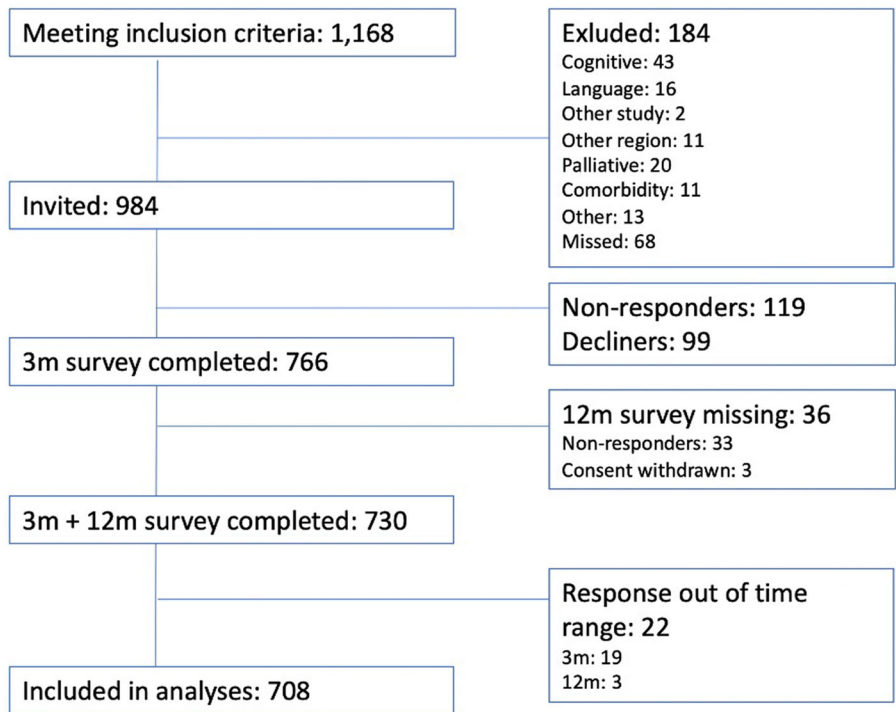


Figure 1. Flow chart of the in-/excluded patients.

Table 1. Patient characteristics ($n = 708$).

	Right-sided colon resection $n = 423$ (59.7 %)	Left-sided colon resection $n = 285$ (40.3 %)
Male gender, n (%)	210 (49.7)	165 (57.9)
Age at surgery, mean (SD)	71.97 (9.88)	68.06 (11.19)
Type of surgery, n (%)		
Right-sided hemicolectomy	344 (81.5)	–
Extended right-sided hemicolectomy	79 (18.7)	–
Left-sided hemicolectomy	–	77 (27.0)
Sigmoid resection	–	208 (73.0)
Body Mass Index, mean (SD)	26.65 (4.90)	27.01 (4.89)
WHO Performance Status, n (%)		
0	283 (68.5)	209 (74.6)
1	104 (25.2)	57 (20.4)
2–4	26 (6.3)	14 (5.0)
Charlson Comorbidity Score, n (%)		
0	161 (39.0)	124 (43.8)
1–2	190 (45.9)	120 (42.4)
>2	63 (15.2)	39 (13.8)
pUICC stage, n (%)		
0–2	273 (66.6)	179 (63.9)
3	120 (29.3)	79 (28.2)
4	17 (4.15)	22 (7.9)
Surgical access, n (%)		
Laparotomy (incl. converted)	82 (19.4)	30 (10.6)
Laparoscopy	340 (80.6)	254 (89.4)
Post-operative chemotherapy, n (%)	96 (22.7)	87 (30.5)
Stoma at 3 months and/or 12 months after surgery, n (%)	13 (3.1)	33 (11.6)
Grade b/c anastomotic leak ^a , n (%)	6 (1.4)	6 (2.1)

WHO: World Health Organisation, pUICC : pathological Union for International Cancer Control.

^aSymptomatic leakage requiring active therapeutic treatment.

A worsening of three other symptoms was also observed among patients having undergone RightSCR. The proportion of patients *never* experiencing flatus incontinence decreased from 3 m to 12 m (38.6% versus 33.1%, $p = 0.03$. The proportion of patients *never* experiencing incontinence for liquid stool declined from 62.3% at 3 m to 54.9% at 12 m ($p = 0.01$). The proportion of patients who *never* experienced faecal urgency decreased from 35.2% at 3 m to 30.2% at 12 m ($p = 0.048$). As shown in Table 2, it seems that the patients are ‘moving down the scale’, which corresponds to a worsening of symptoms.

Also, the proportion of patients who rated their bowel function as ‘Very good/good’ decreased from 68.8% to 63.7% ($p = 0.047$).

LeftSCR: no change or symptom improvement

In patients who had received LeftSCR, no changes were observed in most scores/items from 3 m to 12 m. However, from 3 m to 12 m, an improvement was observed in five bowel function scores/items. A decrease from 3 m to 12 m was observed in the proportion of patients reporting weekly flatus incontinence (47.2% versus 39.0%, $p = 0.02$). Likewise, the proportion reporting weekly liquid stool incontinence decreased from 11.4% to 2.9% ($p < 0.001$), weekly urgency decreased from 33.5% to 22.2% ($p < 0.001$), and weekly night-time defaecation from 13.0% to 7.7% ($p = 0.01$). As shown in Table 2, it seems that the patients are ‘moving up the scale’, which corresponds to an improvement of symptoms.

Also, the St. Mark’s Faecal Incontinence Score decreased (mean difference (95% CI) -0.61 (-1.10 ; -0.13), ($p = 0.01$).

Differences between RightSCR and LeftSCR at 12 m

A total of 31 patients with a stoma at 12 m were not included in these comparative analyses. Among the remaining 677 patients, differences between RightSCR and LeftSCR were found in some bowel symptoms at 12 m. These symptoms are highlighted in the last column of Table 3.

Symptoms more prevalent in RightSCR than in LeftSCR at 12 m

At 12 m, a higher proportion of RightSCR than LeftSCR patients had Bristol Stool Type 6–7 (loose stools) (20.1% versus 5.1%) ($p < 0.001$). Also, RightSCR patients had a poorer function than LeftSCR patients had with regards to the two LARS Score items a) incontinence for liquid stool (‘never’ in 55.0% versus 68.7%, $p < 0.001$) and b) urgency (‘never’ in 29.8% versus 46.9%, $p < 0.001$) (Table 3). Despite these differences, the proportion of patients using constipating agents was similar in the two groups (5.5% versus 5.0%, $p = 0.81$).

Symptoms more prevalent in LeftSCR than in RightSCR at 12 m

At 12 m, hard stool consistency (Bristol Stool Chart Type 1–2) was reported by 10.2% of LeftSCR patients and by 6.0% of RightSCR patients ($p = 0.046$).

LeftSCR patients scored higher (poorer function) in the Abdominal subscale of the PAC-SYM, with a mean difference (95% CI) of -0.25 (-0.34 ; -0.16) ($p < 0.001$) and higher in the Stool subscale of the PAC-SYM, with a mean difference (95%CI) -0.40 (-0.50 ; -0.30) ($p = < 0.001$). However, these small differences are considered clinically irrelevant.

Table 2. Change in bowel function from 3 m to 12 m after surgery, for patients undergoing a right-sided or a left-sided colon resection ($n = 662$).

Right-sided colon resection ($n = 410$) Comparison of 3 m versus 12 m				Left-sided colon resection ($n = 252$) Comparison of 3 m versus 12 m			
Bowel function scores and items				Bowel function scores and items			
3 m	12 m	Difference (95% CI)	p	3 m	12 m	Difference (95% CI)	p
Bristol Stool Chart, n (%)							
1–2 (hard)	24 (6.2)	–0.8 (–4.2; 2.6)	0.63	25 (10.3)	24 (9.8)	–0.4 (–5.7; 4.9)	0.87
3–5 (normal)	291 (75.0)	–0.5 (–5.7; 4.7)	0.84	199 (81.6)	207 (84.8)	3.3 (–2.9; 9.5)	0.27
6–7 (loose)	73 (18.8)	1.3 (–3.3; 5.9)	0.56	20 (8.2)	13 (5.3)	–2.9 (–6.6; 0.8)	0.09
PAC-SYM, median (IQR)							
Abdominal	0.5 (0.0–1.0)	0.00 (–0.05; 0.05)*	0.91	0.5 (0.0–0.8)	0.5 (0.0–0.8)	–0.01 (–0.08; 0.06)*	0.63
Rectal	0.0 (0.0–0.5)	0.07 (0.02; 0.13)*	0.005	0.0 (0.0–0.3)	0.0 (0.0–0.3)	–0.01 (–0.08; 0.05)*	0.64
Stool	0.4 (0.2–0.8)	0.02 (–0.03; 0.08)*	0.30	0.8 (0.4–1.4)	0.8 (0.4–1.4)	0.02 (–0.05; 0.10)*	0.93
Total	0.4 (0.2–0.8)	0.02 (–0.02; 0.06)*	0.37	0.5 (0.3–0.8)	0.5 (0.3–0.9)	0.00 (–0.05; 0.05)*	0.91
LARS Score items							
Flatus incontinence, n (%)							
Never	155 (38.6)	–5.5 (–10.5; –0.4)	0.026	63 (25.6)	60 (24.4)	–1.2 (–7.1; 4.7)	0.66
<1 per week	120 (29.9)	7.7 (2.0; 13.4)	0.008	67 (27.2)	90 (36.6)	9.4 (1.5; 17.2)	0.015
>= 1 per week	127 (31.6)	–2.2 (–6.7; 2.2)	0.30	116 (47.2)	96 (39.0)	–8.1 (–15.4; –0.9)	0.022
Incontinence liquid stool, n (%)							
Never	250 (62.3)	–7.5 (–13.5; –1.9)	0.007	155 (63.0)	169 (68.7)	5.7 (–0.1; 12.2)	0.07
<1 per week	112 (27.9)	8.5 (2.9; 14.1)	0.002	63 (25.6)	70 (28.5)	2.9 (–4.1; 9.8)	0.39
>= 1 per week	39 (9.7)	–1.0 (–4.5; 2.5)	0.55	28 (11.4)	7 (2.9)	–8.5 (–12.9; –4.1)	<0.001
Bowel movement frequency, n (%)							
>= 4 daily	33 (8.2)	0.8 (–2.3; 3.9)	0.61	34 (13.7)	28 (11.3)	–2.4 (–6.8; 2.0)	0.24
1–3 daily	307 (76.6)	–0.5 (–5.2; 4.2)	0.83	176 (71.0)	182 (73.4)	2.4 (–4.0; 8.8)	0.43
<1 daily	61 (15.2)	–0.3 (–4.3; 3.8)	0.90	38 (15.3)	38 (15.3)	0 (–5.3; 5.3)	1.00
Fragmented defaecation, n (%)							
Never	179 (44.9)	–3.8 (–8.6; 1.1)	0.11	94 (38.2)	94 (38.2)	0 (–6.9; 6.9)	1.00
<1 per week	111 (27.8)	2.5 (–3.4; 8.4)	0.38	85 (34.6)	93 (37.8)	3.25 (–4.5; 11.0)	0.39
>= 1 per week	109 (27.3)	1.3 (–3.9; 6.4)	0.62	67 (27.2)	59 (24.0)	–3.25 (–9.9; 3.4)	0.31
Urgency, n (%)							
Never	142 (35.2)	–5.0 (–10.1; 0.2)	0.048	92 (37.1)	119 (48.0)	10.9 (4.4; 17.4)	<0.001
<1 per week	144 (35.6)	1.2 (–4.8; 7.3)	0.68	73 (29.4)	74 (29.8)	0.4 (–6.8; 7.6)	0.91
>= 1 per week	118 (29.2)	3.7 (–1.4; 8.9)	0.14	83 (33.5)	55 (22.2)	–11.3 (–18.1; –4.5)	<0.001
St. Mark's Faecal Incontinence Score, median (IQR)							
Total score	4 (1–7)	–0.10 (–0.47; 0.27)*	0.77	4 (1.5; 7.5)	3 (0.5; 7.0)	–0.61 (–1.10; –0.13)*	0.008
Night-time defaecation^a, n (%)							
Never	332 (83.0)	–0.3 (–4.3; 3.8)	0.90	176 (71.5)	193 (78.5)	6.9 (0.5; 13.4)	0.027
<1 week	44 (11.0)	0.3 (–3.7; 4.2)	0.89	38 (15.5)	34 (13.8)	–1.6 (–7.7; 4.4)	0.57
>= 1 week	24 (6.0)	0.00 (–2.7; 2.7)	1.00	32 (13.0)	19 (7.7)	–5.3 (–9.6; –1.0)	0.009
Use of medication and fibre supplements							
Constipating agents, n (%) (St. Mark's Faecal Incontinence Score item)							
Yes	23 (5.9)	–0.3 (–3.0; 2.5)	0.84	10 (4.1)	11 (4.5)	0.40 (–3.5; 4.3)	0.82
Laxatives^a, n (%)							
Yes	65 (16.5)	–2.8 (–6.2; 0.6)	0.09	47 (19.4)	50 (20.7)	–1.2 (–4.1; 6.6)	0.62
Fibre supplements^a, n (%)							
Yes	98 (24.8)	0.8 (–3.6; 5.1)	0.71	72 (29.4)	66 (26.9)	–2.5 (–8.3; 3.4)	0.38
Self-rated bowel function and quality of life							
Self-rated bowel function^a, n (%)							
Very good/good	278 (68.6)	–4.9 (–10.1; 0.2)	0.047	152 (61.3)	155 (62.5)	1.2 (–5.6; 8.0)	0.71
Acceptable	101 (24.9)	4.7 (–0.8; 10.2)	0.08	76 (30.7)	77 (31.1)	0.4 (–6.9; 7.7)	0.91

(continued)

Table 3. Bowel symptoms in right- and left-sided colon resections 12 months after surgery ($n = 677$).

	Right-sided colon	Left-sided colon	Difference (95% CI)	<i>p</i>
Bowel function scores and single items				
Bristol stool chart, <i>n</i> (%)				
1–2 (hard)	24 (6.0)	26 (10.2)	–4.2 (–8.6; 0.1)	0.046
3–5 (normal)	298 (74.0)	216 (84.7)	–10.8 (–16.9; –4.6)	0.001
6–7 (loose)	81 (20.1)	13 (5.1)	15.0 (10.3; 19.8)	<0.001
PAC SYM, median (IQR)				
Abdominal	0.25 (0.00–1.00)	0.50 (0.00–0.75)	–0.25 (–0.34; –0.16)	<0.001*
Rectal	0.00 (0.00–0.67)	0.00 (0.00–0.67)	0.00 (–0.12; 0.12)	1.00
Stool	0.40 (0.20–1.00)	0.80 (0.40–1.40)	–0.40 (–0.50; –0.30)	<0.001*
Total	0.42 (0.16–0.83)	0.50 (0.25–0.92)	–0.08 (–0.17; 0.01)	0.07
LARS Score items				
Flatus incontinence, <i>n</i> (%)				
Never	134 (32.9)	62 (24.0)	8.9 (2.0; 15.8)	0.01
<1 per week	154 (37.8)	96 (37.2)	0.6 (–6.9; 8.2)	0.87
≥1 per week	119 (29.2)	100 (38.8)	–9.5 (–16.9; –2.1)	0.01
Incontinence liquid stool, <i>n</i> (%)				
Never	224 (55.0)	178 (68.7)	–13.7 (–21.1; –6.3)	<0.001
<1 per week	148 (36.4)	73 (28.2)	8.2 (1.0; 15.4)	0.03
≥1 per week	35 (8.6)	8 (3.1)	5.5 (2.1; 9.0)	0.005
Bowel movement frequency, <i>n</i> (%)				
≥4	36 (8.8)	32 (12.4)	–3.6 (–8.5; 1.3)	0.13
1–3	310 (75.8)	188 (72.9)	2.9 (–3.9; 9.8)	0.40
<1	63 (15.4)	38 (14.7)	0.7 (–4.9; 6.2)	0.81
Fragmented defaecation, <i>n</i> (%)				
Never	165 (40.6)	101 (38.9)	1.8 (–5.8; 9.4)	0.64
<1 per week	126 (31.0)	97 (37.3)	–6.3 (–13.7; 1.1)	0.09
≥1 per week	115 (28.3)	62 (23.9)	4.5 (–2.3; 11.3)	0.20
Urgency, <i>n</i> (%)				
Never	122 (29.8)	122 (46.9)	–17.2 (–24.7; –9.7)	<0.001
<1 per week	152 (37.1)	79 (30.4)	6.7 (–0.6; 14.0)	0.08
≥1 per week	136 (33.2)	59 (22.7)	10.5 (3.7; 17.3)	0.004
St. Mark's Incontinence Score, median (IQR)				
Total score	4.00 (0.50–7.00)	3.5 (0.5–7.00)	0.5 (–0.20; 1.20)	0.16
Night-time defaecation ^a , <i>n</i> (%)				
Never	340 (82.9)	200 (76.9)	6.0 (–0.3; 12.3)	0.06
<1 week	45 (11.0)	36 (13.9)	–2.9 (–8.1; 2.3)	0.27
≥1 week	25 (6.1)	24 (9.2)	–3.1 (–7.4; 1.1)	0.13
Use of medication and fibre supplements				
Constipating agents, <i>n</i> (%) (St. Mark's Faecal Incontinence Score item)				
Yes	22 (5.5)	13 (5.0)	0.4 (–3.0; 3.9)	0.81
Laxatives ^a , <i>n</i> (%)				
Yes	57 (14.1)	51 (20.0)	–5.9 (–11.9; 0.1)	0.05
Fibre supplements ^a , <i>n</i> (%)				
Yes	104 (25.5)	70 (27.1)	–1.6 (–8.5; 5.2)	0.64
Self-rated bowel function and quality of life				
Self-rated bowel function ^a , <i>n</i> (%)				
Very good/good	263 (63.7)	163 (62.7)	1.1 (–6.4; 8.6)	0.76
Acceptable	122 (29.6)	81 (31.2)	–1.5 (–8.7; 5.6)	0.67
Bad/very bad	27 (6.6)	16 (6.2)	0.4 (–3.4; 4.2)	0.84
Impact of bowel function on quality of life ^a , <i>n</i> (%)				
Some/a lot ^b	68 (16.5)	48 (18.5)	–2.2; (–8.2; 3.7)	0.46
EQ5D-5L, median (IQR)				
EQ5D index value	0.95 (0.88; 1.00)	0.96 (0.90; 1.00)	–0.01 (–0.03; 0.02)	0.59

Patients with a stoma at 12 months were not included ($n = 31$).

PAC-SYM: Patient Assessment of Constipation Symptoms; LARS Score: Low Anterior Resection Syndrome Score; EQ5D-5L: EuroQol 5 Dimensions – 5 Levels instrument.

^a*ad hoc* items.

^b*versus* 'not at all/a little'. *Clinically irrelevant difference.

Yellow: Worse symptoms in **right**-sided – than in **left**-sided resected patients, $p < 0.05$.

Blue: Worse symptoms in **left**-sided – than in **right**-sided resected patients, $p < 0.05$.

regeneration and healing of the nervous supply to the defaecation reflexes and by patients changing their diet and toilet habits (timing and positioning) to cope with their new situation [35,36].

Main findings; differences between groups at 12 m

In general, a high prevalence of bowel symptoms was found at 12 m in both groups, but with inter-group differences in the

prevalence of the individual symptoms. A significantly larger proportion of RightSCR patients reported loose stools, liquid stool incontinence, and urgency, whereas a larger proportion of LeftSCR patients reported hard stools and flatus incontinence. Although symptom patterns differed between the two groups at 12 m, no statistically significant differences were found in self-rated bowel function or impact of bowel function on QoL. This might indicate that any kind of severe bowel problems may affect QoL, independently of the specific type of symptoms.

Table 4. Associations between demographic/clinical variables and QoL (N = 701).

	Affected QoL*	Adjusted OR (95 %CI) ^b	<i>p</i>
Age ≤ 64 years (n = 173)	27.2 %	2.58 (1.63; 4.10)	<0.001
Age > 64 years (n = 528)	15.3 %	Ref	
Female (n = 331)	21.8%	1.54 (0.99; 2.31)	0.06
Male (n = 370)	15.1%	Ref	
BMI < 25 (n = 270)	19.3%	1.11 (0.74; 1.70)	0.63
BMI ≥ 25 (n = 421)	17.6 %	Ref	
Left-sided (n = 282)	20.6 %	1.27 (0.84; 1.96)	0.27
Right-sided (n = 419)	16.7 %	Ref	
Laparotomy (n = 110)	20.9 %	1.33 (0.76; 2.34)	0.32
Laparoscopy (n = 589)	17.8 %	Ref	
No post-operative chemo (n = 518)	19.9 %	1.47 (0.76; 2.87)	0.25
Post-operative chemo (n = 183)	13.7 %	Ref	
pUICC 0–2 (n = 449)	19.8 %	3.28 (0.88; 12.17)	0.08
pUICC 3 (n = 196)	15.8 %	2.79 (0.77; 10.12)	0.12
pUICC 4 (n = 38)	7.9 %	Ref	
WHO performance 0–1 (n = 648)	18.1 %	Ref	0.49
WHO performance 2–4 (n = 40)	25.0 %	1.36 (0.56; 3.30)	
Charlson comorbidity score 0–1 (n = 385)	16.4 %	Ref	0.09
Charlson comorbidity score > 1 (n = 311)	20.9 %	1.44 (0.95; 2.18)	
No stoma at 12 m (n = 670)	17.2 %	Ref	<0.001
Stoma at 12 m (n = 31)	41.9 %	4.32 (1.9 (9.83)	

*Patients responding 'somewhat' or 'very much' to the question 'Overall, how much does your bowel function affect your QoL?' at 12 m.

^bn = 663.

p-values <0.05 are shown in bold font.

Of major interest, we found that 18.3% of all patients reported bowel-related impaired QoL 12 m after surgery; a result which corresponds well with previous publications, reporting that QoL was impaired in one of every five patients [18,37]. Whereas the multivariate logistic regression analyses showed that type of surgery was not associated with impaired QoL, we found that younger age and having a stoma were highly associated with bowel-related impaired QoL 12 m after surgery. Again, our results are in line with those of several other studies showing that these factors are closely associated [38–40], although firm conclusions regarding the association between having a stoma and generic cancer-related QoL measures like the FACT-C and the EORTC QOL tools have previously proven to be difficult to draw [41].

Another finding is that although a significantly higher proportion of RightSCR patients than LeftSCR patients have loose stools, no differences were observed between the groups regarding the use of constipating agents or fibre supplements. This may possibly be explained by bowel dysfunction being underdiagnosed, and the finding highlights the importance of routine screening and treatment of identified late sequelae not only in RC patients but also in CC patients. Although fewer CC patients than RC patients are affected by bowel dysfunction, the incidence of CC is approximately twice as high as RC, i.e., the total number of CC patients affected by bowel dysfunction is likely to be as high as the total number of affected RC patients.

Possible consequences of bowel dysfunction after CC

Previous studies have demonstrated that bowel dysfunction may have a significant impact on patients' overall QoL

[17,42,43]. In addition, recent studies have shown that CC patients' affiliation with the labour market is negatively affected up to ten years after surgery [44,45]. Although the underlying causes for this remain unclear, it seems reasonable to assume that severe bowel dysfunction may play a role; a hypothesis that must be explored in future, appropriately designed studies. Such studies are increasingly relevant as the prevalence of working-age CRC survivors is growing because of an increase in early-onset CRC, improved survival and rising retirement age in many countries.

Future perspectives

Whereas late sequelae after RC have gained increasing attention in recent decades, CC patients' late sequelae remain largely neglected. The present and previous studies [16–18] have shown that many CC patients suffer from long-term bowel dysfunction and that most bowel symptoms, particularly after right-sided resections, do not seem to resolve spontaneously. Since many bowel symptoms may be treated effectively by simple measures readily available in modern healthcare systems [46,47] a cost-effective systematic screening for bowel dysfunction via electronic PROMs and early intervention in the affected patients are advisable to improve patients' QoL [48]. Frequently, diarrhoea after RightSCR may be treated effectively once the correct diagnosis has been established, which is often bile acid malabsorption or small bowel bacterial overgrowth [37,46,49]. Also, 'LARS-like' symptoms, chronic constipation, and obstructed defaecation, which are common after LeftSCR, may be managed effectively in dedicated late sequelae clinics [50].

Limitations

This study has some limitations. Firstly, for various reasons, 28% of the initially eligible patients were not included in the analyses. Consequently, the results might not be representative of the whole CC population. Secondly, the included patients were all from Denmark, a country with highly centralised care of cancer patients. Hence, all patients were operated in high-volume, specialised tertiary referral centres. This might affect the generalisability, making it difficult to extrapolate the rates of bowel dysfunction of our patients to those from countries with differently organised healthcare systems. Also, the impact on QoL of a stoma or severe bowel dysfunction may differ significantly across cultures [39,40]. However, we believe that the results of this study are largely generalisable to countries managing cancer treatment in a healthcare system similar to the Danish.

Another limitation is the lack of information on level of division of the vessels and central lymph node resection (D2/D3). Currently, we do not have a clear-cut definition of how to perform D3 resection, and hence, this information has not been registered. Therefore, we could not distinguish between the groups. Nevertheless, it would be relevant to investigate in future studies.

Conclusion

Among CC patients undergoing a RightSCR, bowel symptoms and QoL did not improve spontaneously during the first year after surgery. Among patients undergoing a LeftSCR, some symptoms improved. Still, 12 m after surgery both RightSCR patients and LeftSCR patients were affected by bowel dysfunction, and 18% reported that it impacted their QoL negatively. These findings warrant implementation of an early systematic screening for and treatment of bowel dysfunction in standard CC follow up programmes.

Ethical approval

This survey-based study did not require consent from the National Committee on Health Research Ethics in Denmark. It was registered with the Danish Data Protection Agency as Health Science Research of the Central Denmark Region.

Patient consent

Participants signed an informed consent form after receiving information about the study.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

Financial support for this study was provided by The Danish Cancer Society [grant R192-A11536]. The funders had no role in study design, data collection, analysis, publishing strategy or preparation of the manuscript. The authors have no conflicts of interest to declare.

ORCID

Annette Boesen Bräuner  <http://orcid.org/0000-0002-7295-0318>
 Nicolas Avellaneda  <http://orcid.org/0000-0002-6802-7125>
 Peter Christensen  <http://orcid.org/0000-0002-6611-3935>
 Asbjørn Mohr Drewes  <http://orcid.org/0000-0001-7465-964X>
 Katrine Jøssing Emmertsen  <http://orcid.org/0000-0001-6153-4346>
 Klaus Krogh  <http://orcid.org/0000-0001-9168-2403>
 Michael Bødker Lauritzen  <http://orcid.org/0000-0002-3748-725X>
 Uffe Schou Løve  <http://orcid.org/0000-0002-2409-0499>
 Ole Thorlacius-Ussing  <http://orcid.org/0000-0003-4963-1551>
 Therese Juul  <http://orcid.org/0000-0002-5411-4826>

Data availability statement

The data that support the findings of this study are available from the corresponding author, TJ, upon reasonable request.

Acknowledgements

The authors wish to acknowledge the nurses Bibi Damsgaard, Rikke Krogh Demming, Gitte Kjær Sørensen, Margit Majgaard, Karen Irene Jacobsen, Dorte Kløve Kjær and Helle Vindfeldt Rasmussen for their great efforts in collecting data for this study.

References

- Bray F, Ferlay J, Soerjomataram I, et al. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin*. 2018;68(6):394–424. doi: [10.3322/caac.21492](https://doi.org/10.3322/caac.21492).
- NORDCAN. 2022. [cited 2021 Sep 15]. https://nordcan.iarc.fr/en/dataviz/trends?mode=cancer&group_populations=1&multiple_cancers=1&sexes=1_2&cancers=520&types=0_1.
- Araghi M, Arnold M, Rutherford MJ, et al. Colon and rectal cancer survival in seven high-income countries 2010–2014: variation by age and stage at diagnosis (the ICBP SURVMARK-2 project). *Gut*. 2021;70(1):114–126. doi: [10.1136/gutjnl-2020-320625](https://doi.org/10.1136/gutjnl-2020-320625).
- Chambers AC, Dixon SW, White P, et al. Demographic trends in the incidence of young-onset colorectal cancer: a population-based study. *Br J Surg*. 2020;107(5):595–605. doi: [10.1002/bjs.11486](https://doi.org/10.1002/bjs.11486).
- Vuik FE, Nieuwenburg SA, Bardou M, et al. Increasing incidence of colorectal cancer in young adults in Europe over the last 25 years. *Gut*. 2019;68(10):1820–1826. doi: [10.1136/gutjnl-2018-317592](https://doi.org/10.1136/gutjnl-2018-317592).
- Saad El Din K, Loree JM, Sayre EC, et al. Trends in the epidemiology of young-onset colorectal cancer: a worldwide systematic review. *BMC Cancer*. 2020;20(1):288. doi: [10.1186/s12885-020-06766-9](https://doi.org/10.1186/s12885-020-06766-9).
- Bertelsen CA, Neuenschwander AU, Jansen JE, et al. 5-Year outcome after complete mesocolic excision for right-sided Colon cancer: a population-based cohort study. *Lancet Oncol*. 2019; 20(11):1556–1565. doi: [10.1016/S1470-2045\(19\)30485-1](https://doi.org/10.1016/S1470-2045(19)30485-1).
- van den Berg I, Coebergh van den Braak RRR, van Vugt JLA, et al. Actual survival after resection of primary colorectal cancer: results from a prospective multicenter study. *World J Surg Oncol*. 2021; 19(1):96. doi: [10.1186/s12957-021-02207-4](https://doi.org/10.1186/s12957-021-02207-4).
- Juul T, Ahlberg M, Biondo S, et al. Low anterior resection syndrome and quality of life: an international multicenter study. *Dis Colon Rectum*. 2014;57(5):585–591. doi: [10.1097/DCR.0000000000000116](https://doi.org/10.1097/DCR.0000000000000116).
- Fedder ML, Emmertsen KJ, Laurberg S. Quality of life with or without sphincter preservation for rectal cancer. *Colorectal Dis*. 2019;21(9):1051–1057. doi: [10.1111/codi.14684](https://doi.org/10.1111/codi.14684).
- Fedder M-L, Jensen TS, Laurberg S. Chronic pain in the pelvic area or lower extremities after rectal cancer treatment and its impact on quality of life: a population-based cross-sectional study. *Pain*. 2015; 156(9):1765–1771. doi: [10.1097/j.pain.0000000000000237](https://doi.org/10.1097/j.pain.0000000000000237).
- Bregendahl S, Emmertsen KJ, Lindegaard JC, et al. Urinary and sexual dysfunction in women after resection with and without preoperative radiotherapy for rectal cancer: a population-based

- cross-sectional study. *Colorectal Dis.* 2015;17(1):26–37. doi: [10.1111/codi.12758](#).
- [13] Sun R, Dai Z, Zhang Y, et al. The incidence and risk factors of low anterior resection syndrome (LARS) after sphincter-preserving surgery of rectal cancer: a systematic review and meta-analysis. *Support Care Cancer.* 2021;29(12):7249–7258. doi: [10.1007/s00520-021-06326-2](#).
- [14] Thyo A, Laurberg S, Emmertsen KJ. Impact of bowel and stoma dysfunction on female sexuality after treatment for rectal cancer. *Colorectal Dis.* 2020;22(8):894–905. doi: [10.1111/codi.14987](#).
- [15] Pappou EP, Temple LK, Patil S, et al. Quality of life and function after rectal cancer surgery with and without sphincter preservation. *Front Oncol.* 2022;12:944843. doi: [10.3389/fonc.2022.944843](#).
- [16] Verkuil SJ, Jonker JE, Trzpis M, et al. Functional outcomes of surgery for Colon cancer: a systematic review and meta-analysis. *Eur J Surg Oncol.* 2021;47(5):960–969. doi: [10.1016/j.ejso.2020.11.136](#).
- [17] Elfeki H, Larsen HM, Emmertsen KJ, et al. Bowel dysfunction after sigmoid resection for cancer and its impact on quality of life. *Br J Surg.* 2019;106(6):805. doi: [10.1002/bjs.10979](#).
- [18] Larsen HM, Elfeki H, Emmertsen KJ, et al. Long-term bowel dysfunction after right-sided hemicolectomy for cancer. *Acta Oncol.* 2020;59(10):1240–1245. doi: [10.1080/0284186X.2020.1772502](#).
- [19] Buchli C, Martling A, Sjøvall A. Low anterior resection syndrome after right- and left-sided resections for colonic cancer. *BJS Open.* 2019;3(3):387–394. doi: [10.1002/bjs.5.50128](#).
- [20] Juul T, Brauner AB, Drewes AM, et al. Systematic screening for late sequelae after colorectal cancer-a feasibility study. *Colorectal Dis.* 2021;23(2):345–355. doi: [10.1111/codi.15519](#).
- [21] DCCG. Danish Colorectal Cancer Group (DCCG) National annual report 2020. 2022. [cited 2022 Jun 30]. <https://dccg.dk/wp-content/uploads/2021/10/DCCG-Aarsrapport-2020-publiceret.pdf>.
- [22] e-Boks.dk. 2021. [cited 2022 Jun 25]. <https://www.e-boks.com/danmark/en/>.
- [23] Ingeholm P, Gogenur I, Iversen LH. Danish colorectal cancer group database. *Clin Epidemiol.* 2016;8:465–468. doi: [10.2147/CLEP.S99481](#).
- [24] Klein MF, Gogenur I, Ingeholm P, et al. Validation of the Danish colorectal cancer group (dccg.dk) database - on behalf of the Danish colorectal cancer group. *Colorectal Dis.* 2020;22(12):2057–2067. doi: [10.1111/codi.15352](#).
- [25] O'Donnell LJ, Virjee J, Heaton KW. Detection of pseudodiarrhoea by simple clinical assessment of intestinal transit rate. *BMJ.* 1990;300(6722):439–440. doi: [10.1136/bmj.300.6722.439](#).
- [26] Blake MR, Raker JM, Whelan K. Validity and reliability of the Bristol stool form scale in healthy adults and patients with diarrhoea-predominant irritable bowel syndrome. *Aliment Pharmacol Ther.* 2016;44(7):693–703. doi: [10.1111/apt.13746](#).
- [27] Frank L, Kleinman L, Farup C, et al. Jr. Psychometric validation of a constipation symptom assessment questionnaire. *Scandinavian Journal of Gastroenterology.* 1999;34(9):870–877.
- [28] Yiannakou Y, Tack J, Piessevaux H, et al. The PAC-SYM questionnaire for chronic constipation: defining the minimal important difference. *Aliment Pharmacol Ther.* 2017;46(11–12):1103–1111. doi: [10.1111/apt.14349](#).
- [29] Emmertsen KJ, Laurberg S. Low anterior resection syndrome score: development and validation of a symptom-based scoring system for bowel dysfunction after low anterior resection for rectal cancer. *Ann Surg.* 2012;255(5):922–928. doi: [10.1097/SLA.0b013e31824f1c21](#).
- [30] Vaizey CJ, Carapeti E, Cahill JA, et al. Prospective comparison of faecal incontinence grading systems. *Gut.* 1999;44(1):77–80. doi: [10.1136/gut.44.1.77](#).
- [31] Jensen MB, Jensen CE, Gudex C, et al. Danish population health measured by the EQ-5D-5L. *Scand J Public Health.* 2023;51(2):241–249. doi: [10.1177/14034948211058060](#).
- [32] Walters SJ, Brazier JE. Comparison of the minimally important difference for two health state utility measures: EQ-5D and SF-6D. *Qual Life Res.* 2005;14(6):1523–1532. doi: [10.1007/s11136-004-7713-0](#).
- [33] Pickard AS, Neary MP, Cella D. Estimation of minimally important differences in EQ-5D utility and VAS scores in cancer. *Health Qual Life Outcomes.* 2007;5:70. doi: [10.1186/1477-7525-5-70](#).
- [34] Larsen HM, Krogh K, Borre M, et al. Chronic loose stools following right-sided hemicolectomy for Colon cancer and the association with bile acid malabsorption and small intestinal bacterial overgrowth. *Colorectal Dis.* 2023;25(4):600–607. doi: [10.1111/codi.16409](#).
- [35] Varghese C, Wells CI, O'Grady G, et al. The longitudinal course of low-anterior resection syndrome: an individual patient meta-analysis. *Ann Surg.* 2022;276(1):46–54. doi: [10.1097/SLA.0000000000005423](#).
- [36] Laursen BS, Sorensen GK, Majgaard M, et al. Coping strategies and considerations regarding low anterior resection syndrome and quality of life among patients with rectal cancer; a qualitative interview study. *Front Oncol.* 2022;12:1040462. doi: [10.3389/fonc.2022.1040462](#).
- [37] Hope C, Reilly J, Lund J, et al. Systematic review: the effect of right hemicolectomy for cancer on postoperative bowel function. *Support Care Cancer.* 2020;28(10):4549–4559. doi: [10.1007/s00520-020-05519-5](#).
- [38] Vonk-Klaassen SM, de Vocht HM, den Ouden ME, et al. Ostomy-related problems and their impact on quality of life of colorectal cancer ostomates: a systematic review. *Qual Life Res.* 2016;25(1):125–133. doi: [10.1007/s11136-015-1050-3](#).
- [39] Krogsgaard M, Kristensen HO, Furnee EJB, et al. Life with a stoma across five european countries-a cross-sectional study on long-term rectal cancer survivors. *Support Care Cancer.* 2022;30(11):8969–8979. doi: [10.1007/s00520-022-07293-y](#).
- [40] Kristensen HO, Thyo A, Emmertsen KJ, et al. Surviving rectal cancer at the cost of a colostomy: global survey of long-term health-related quality of life in 10 countries. *BJS Open.* 2022;6(6):zrac085. doi: [10.1093/bjsopen/zrac085](#).
- [41] Lawday S, Flamey N, Fowler GE, et al. Quality of life in restorative versus non-restorative resections for rectal cancer: systematic review. *BJS Open.* 2021;5(6):zrab101. doi: [10.1093/bjsopen/zrab101](#).
- [42] Pieniowski EHA, Nordenvall C, Palmer G, et al. Prevalence of low anterior resection syndrome and impact on quality of life after rectal cancer surgery: population-based study. *BJS Open.* 2020;4(5):935–942. doi: [10.1002/bjs.5.50312](#).
- [43] Pieniowski EHA, Palmer GJ, Juul T, et al. Low anterior resection syndrome and quality of life after Sphincter-Sparing rectal cancer surgery: a long-term longitudinal follow-up. *Dis Colon Rectum.* 2019;62(1):14–20. doi: [10.1097/DCR.0000000000001228](#).
- [44] Pedersen P, Laurberg S, Andersen NT, et al. Differences in work participation between incident Colon and rectal cancer patients-a 10-year follow-up study with matched controls. *J Cancer Surviv.* 2022;16(1):73–85. doi: [10.1007/s11764-021-01005-x](#).
- [45] Juul T, Laurberg S, Andersen NT, et al. Labor market attachment 2 years after colorectal cancer Surgery - A population-based study. *Annals of Surgery Open.* 2022;3(1)(1):e134. doi: [10.1097/AS9.0000000000000134](#).
- [46] Larsen HM, Borre M, Christensen P, et al. Clinical evaluation and treatment of chronic bowel symptoms following cancer in the Colon and pelvic organs. *Acta Oncol.* 2019;58(5):776–781. doi: [10.1080/0284186X.2018.1562211](#).
- [47] Jackson A, Lalji A, Kabir M, et al. The efficacy of a low-fat diet to manage the symptoms of bile acid malabsorption - outcomes in patients previously treated for cancer. *Clin Med.* 2017;17(5):412–418. doi: [10.7861/clinmedicine.17-5-412](#).
- [48] Laurberg S, Juul T, Christensen P, et al. Time for a paradigm shift in the follow-up of colorectal cancer. *Colorectal Dis.* 2021;23(2):341–344. doi: [10.1111/codi.15401](#).
- [49] Yde J, Larsen HM, Laurberg S, et al. Chronic diarrhoea following surgery for Colon cancer-frequency, causes and treatment options. *Int J Colorectal Dis.* 2018;33(6):683–694. doi: [10.1007/s00384-018-2993-y](#).
- [50] Haas S, Mikkelsen AH, Kronborg CJS, et al. Management of treatment-related sequelae following colorectal cancer. *Colorectal Dis.* 2023;25(3):458–488. doi: [10.1111/codi.16299](#).

Appendix A

Table A1. PROMs included in the survey.

Tool	Description	Interpretation/notes
The Bristol Stool Form Scale (25,26)	A tool combining graphical illustrations with text to classify stool consistency into seven types.	Types 1 and 2 are considered abnormally hard stools; types 3, 4 and 5 are considered normal; whereas types 6 and 7 are considered abnormally loose/liquid stools
The Patient Assessment of Constipation Symptoms (PAC-SYM) (27)	Consists of 12 items assigned to three subscales and a total score: Abdominal Symptoms (four items; abdominal discomfort, pain, bloating and cramps), Rectal Symptoms (three items; painful bowel movements, rectal burning and rectal bleeding/tearing) and Stool Symptoms (five items; incomplete bowel movements, hard stools, small portions, straining and false alarm), and Total Score (all 12 items). Each item is measured on a five-point Likert-like scale scored from 0 (absent) to 4 (very severe).	Lower scores equal a lower symptom severity. The minimal important difference (MID) for PAC-SYM has previously been established to be 0.6 points (28)
The Low Anterior Resection Syndrome Score (LARS score) (29)	Consists of five items, which have proven to be strongly correlated with bowel-related impact on QoL in RC patients. The response options for items covering incontinence for flatus and liquid stool, fragmented defaecation and faecal urgency are 'Never, < 1/week, < /= 1 per week', whereas the response options for daily frequency of bowel movements are '> /= 4, 1–3, < 1'.	A summary score, based on a weighted scoring system, facilitates categorisation into three groups: no, minor, major LARS. However, the scoring system was developed specifically for and validated in cohorts of RC patients only. Therefore, the summarised score was not analysed in the present study.
The St. Marks Faecal Incontinence Score/Vaizey Score (30)	Measures faecal incontinence severity by means of four items (Solid/liquid/gas incontinence and lifestyle alteration) scored on a five-point Likert-like scale based on the frequency of the symptom ('Never'/0 points, 'Always'/4 points); and, in addition, the use of pads ('Yes'/2 points), usage of anti-diarrhoeal medication ('Yes'/2 points) and urgency symptoms (Yes/4 points). The total score ranges from 0 to 24.	Lower scores equal a lower symptom severity. The original score was initially developed to be completed by a clinician. The score used in this study is an adapted version which can be completed by the patients. It has not yet been formally validated.
EuroQoL 5 Dimensions – 5 levels (EQ5D-5L) (31)	A generic QoL questionnaire consisting of five items measuring mobility, self-care, usual activities, pain/discomfort and anxiety/depression. The EQ5D-5L establishes five categories for each item (from no problems to extreme problems).	Higher scores equal better QoL. The minimally important difference of the EQ-5D utility score has been reported to be 0.08 among cancer patients (32,33)
<i>Ad hoc</i> items	Single items regarding night-time defaecation ('Never, < 1/week, < /= 1 per week') and use of laxative agents and fibre supplements (Yes/No). Two questions regarding self-rated bowel function and impact on QoL: 'How would you evaluate your bowel function over the past four weeks?' (Very good, good, acceptable, poor, very poor) 'Overall, how much does your bowel function affect your quality of life?' (Not at all, a little, somewhat, very much).	