Low anterior resection syndrome in a Scandinavian population of patients with rectal cancer: a longitudinal follow-up within the QoLiRECT study

S. Sandberg*†, D. Aslund*†, T. Bisgaard‡, D. Bock*, E. González*, L. Karlsson*, P. Matthiessen§, B. Ohlsson¶, J. Park*†, J. Rosenberg**, S. Skullman††, M. Sörensson‡‡ and E. Angenete*†

*Department of Surgery, SSORG – Scandinavian Surgical Outcomes Research Group, Institute of Clinical Sciences, Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden; †Department of Surgery, Region Västra Götaland, Sahlgrenska University Hospital/Ostra, Gothenburg, Sweden; ‡Department of Surgery, Centre for Surgical Science, University Hospital of Zealand, Køge, Denmark; §Department of Surgery, Faculty of Medicine and Health, Örebro University, Örebro, Sweden; ¶Department of Surgery, Blekinge Hospital, Karlshamn, Sweden; **Department of Surgery, Herlev Hospital, University of Copenhagen, Copenhagen, Denmark; ††Department of Surgery, Skaraborgs Hospital Skövde, Skövde, Sweden; and ‡‡Department of Surgery, Karlstad Hospital, Karlstad, Sweden

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Abstract

**Aim** Low anterior resection syndrome (LARS) is common after low anterior resection. Our aim was to evaluate the prevalence and ‘bother’ (subjective, symptom-associated distress) of major LARS after 1 and 2 years, identify possible risk factors and relate the bowel function to a reference population.

**Method** The QoLiRECT (Quality of Life in RECTal cancer) study is a Scandinavian prospective multicentre study including 1248 patients with rectal cancer, of whom 552 had an anterior resection. Patient questionnaires were distributed at diagnosis and after 1, 2 and 5 years. Data from the baseline and at 1- and 2-year follow-up were included in this study.

**Results** The LARS score was calculated for 309 patients at 1 year and 334 patients at 2 years. Prevalence was assessed by a generalized linear mixed effects model. Major LARS was found in 63% at 1 year and 56% at 2 years. Bother was evident in 55% at 1 year, decreasing to 46% at 2 years. Major LARS was most common among younger women (69%). Among younger patients, only marginal improvement was seen over time (63–59%), for older patients there was more improvement (62–52%). In the reference population, the highest prevalence of major LARS-like symptoms was noted in older women (12%). Preoperative radiotherapy, defunctioning stoma and tumour height were found to be associated with major LARS.

**Conclusion** Major LARS is common and possibly persistent over time. Younger patients, especially women, are more affected, and perhaps these patients should be prioritized for early stoma closure to improve the chance of a more normal bowel function.

**Keywords** Low anterior resection syndrome, rectal cancer, bowel dysfunction

**What does this paper add to the literature?** Most of the available literature about bowel dysfunction after rectal surgery only involves cross-sectional data. This paper investigates bowel dysfunction in a large prospective cohort in a longitudinal setting with follow-up at 1 and 2 years after surgery.

Introduction

With the introduction of minimally invasive surgical techniques, sphincter-saving surgery is often possible with very low or locally advanced rectal tumours without compromising the oncological results [1]. As more patients survive rectal cancer, the long-term side effects and functional results have become increasingly important [2]. A common consequence of low anterior resection is disordered bowel function, known as ‘low anterior resection syndrome’ (LARS). LARS involves a range of symptoms including incontinence,
urgency, evacuatory dysfunction and abnormal frequency of bowel movements [3].

It has been reported that some degree of bowel dysfunction may affect up to 90% of patients following rectal resection [3–5]. However, there is considerable variability in the literature due to inconsistent terminology and lack of an international validated scoring system. To enable clinical evaluation of LARS, the LARS questionnaire was developed in 2012 as a scoring tool taking into account the impact of bowel dysfunction on overall quality of life (QoL) [6]; recently, work has begun to reach an international consensus definition of LARS [7].

The actiology of LARS is yet not entirely understood [8] and there are recent data indicating that LARS-like symptoms are present in the general population [9–11]. This emphasizes the importance of reflecting on the relationship between bother (subjective, symptom-associated distress) and LARS score, as we only need to evaluate and treat symptoms that create an impact or affect a patient’s QoL.

The primary aim of this study was to evaluate the prevalence and bother of major LARS at 1 and 2 years after anterior resection in a prospective cohort, and to relate the bowel dysfunction to a reference population. A further aim was to investigate possible risk factors related to major LARS.

Method

The LARS score

The LARS score was developed in 2012 as a self-administered questionnaire measuring bowel dysfunction after rectal cancer surgery [6].

The five questions address concerns that were found to be the most important: ‘incontinence for flatus’, ‘incontinence for liquid stool’, ‘frequency of bowel movements’, ‘clustering of stools’ and ‘urgency’. All items showed significant correlation with their impact on QoL and were designated score values accordingly.

The range of the score is 0–42, with 0–20 being no LARS, 21–29 minor LARS and 30–42 major LARS. The questionnaire has been validated in several languages [12].

The QoLiRECT study

The QoLiRECT (Quality of Life in RECTal cancer) study is a prospective observational multicentre study of QoL and functional outcome in patients with rectal cancer in Sweden and Denmark. The study was registered at ClinicalTrials.gov (NCT01477229).

Between 2012 and 2015, the 16 colorectal units involved included 1248 patients. Patients were considered potentially eligible when diagnosed with a biopsy-confirmed adenocarcinoma of the rectum and were invited to participate when presented with a treatment plan but before treatment was initiated. Informed consent was obtained and patients were included regardless of tumour stage or intended treatment. Exclusion criteria were age below 18 years and patients who could not read or understand Swedish or Danish. Patients responded to extensive questionnaires at four time points: at diagnosis and after 1, 2 and 5 years. As the 5-year follow-up has to date not been reached, data from the baseline and at the 1- and 2-years follow-ups were included in this study.

The development of the questionnaire has been previously described in detail [13]. A clinimetric approach [14] was used where the aim was to address various aspects such as prevalence, severity and distress of each symptom separately rather than summarizing items into a single global score. One feature of this approach is the provision of a sufficient number of response categories to which the subject may relate.

The questionnaires included questions on functional aspects such as bowel, urinary and sexual function as well as mental and social function, co-morbidity, personality characteristics and distress related to diagnosis and treatment. The follow-up questionnaires focused on the effects of treatment, with a detailed exploration of QoL and functional impairments. Additionally, the questionnaires included generic instruments to measure health status, such as the EQ-5D-3L [15] and the 29-item Sense of Coherence scale (SOC-29) [16].

Regarding bowel function, the questions were equivalent to the LARS score questions, with the addition of more response options that were congruent with the other questions in the questionnaires. It was possible to correlate exactly the answers with the LARS score [6] (Appendix S1 in the online Supporting Information).

The subjective, symptom-associated distress, expressed as ‘bother’, was derived from the question ‘If you, for the rest of your life, would live with your bowel function as it has been during the last month, how would you feel about it?’ with a cut-off between ‘It would not bother me at all’ and ‘It would somewhat bother me’. The use of a verbal scale of intensity to assess distress has been described by Steineck et al. [17].

At baseline only questions concerning leakage of stool, frequency of bowel movements and bother were used. Preoperative sphincter function was assessed through questions regarding incontinence. Impaired bowel function was expected due to the newly diagnosed cancer, and also the LARS score was not published at the time.
the questionnaire was developed [6]. Therefore, no baseline data on LARS score could be presented.

The analyses were based on data collected from the questionnaires as well as clinical data from the Danish and Swedish national quality registers.

The study population consisted of all patients who had an anterior resection, who responded to at least one follow-up questionnaire and had bowel continuity. Patients with preexisting bowel disease and those who described bowel dysfunction were included. Patients with a defunctioning stoma were only included after the stoma had been reversed.

**Swedish reference population**

A cohort of 3000 Swedish individuals was randomly selected from the general population via the Swedish Tax Agency [18]. The individuals were contacted by mail and telephone call and, after obtaining informed consent, they were sent a questionnaire. A total of 1078 individuals (median age 63 years, 52% female) answered a questionnaire similar to the one used in the QoLiRECT study.

Questions regarding bowel function were comparable to the LARS questions but formulated slightly differently and with more response options; for example ‘Have you leaked gas (involuntarily) in the last month?’ with five response options from ‘No, never’ to ‘Yes, 4 or more times per day’ where the response options could be dichotomised to fully correspond to the LARS score. The original LARS score was not published when the questionnaire was constructed.

The aim of the reference population was to serve as a benchmark to put the prevalence of major LARS among the current study population into perspective. Hence, the aim was not a causal effect estimation.

**Risk factor assessment**

For risk factor analysis, the following variables were chosen based on previous publications and clinical expertise: sex, age, preexisting faecal leakage/sphincter dysfunction, tumour height, preoperative radiotherapy, pre- and postoperative chemotherapy, type of anastomosis, anastomotic leakage, defunctioning stoma and time until stoma reversal.

As there have been concerns regarding the validity of the frequency of anastomotic dehiscence in the Swedish Colorectal Cancer Registry [19], data from the registry were supplemented by information from the questionnaires. However, due to missing data it was not possible to use this variable in the analysis. For the same reason it was not possible to analyse type of anastomosis and time until stoma reversal.

**Statistical analysis**

The prevalence of major LARS-like symptoms in the reference population was reported using crude rates with 95% confidence intervals. The prevalence in the study population was assessed by a generalized linear mixed effects model with a logit link and Bernoulli distribution [20]. Random intercept and time effect (slope), with an AR(1) covariance structure were used to account for the intra-patient dependence. Sex and time were included as a fixed effect and age as a continuous covariate as well as two- and three-way interaction effects. The Kenward–Roger degrees of freedom approximation was used. Individual random effect (conditional) predictions as well as least-square mean fixed effect (marginal) predictions were displayed graphically.

The mean effects were evaluated at the first and third quantiles of age at inclusion, 60 and 72 years, respectively. The prevalence was compared between sex, age and time and reported as odds ratio (OR) and 95% confidence intervals (CI).

In the risk factor analysis, the average of the scores at 1- or 2-year follow-up (or a single score if only a single value was available) was used. Marginal and adjusted associations were quantified using log-binomial regression. Based on prior assumptions regarding confounders and mediators for each of the factors, adjusted analyses were performed, and possible confounders were included. In order to avoid adjusting for mediators, referred to as the ‘Table 2 fallacy’, separate adjusted analyses were performed for each variable and the choice of variables was based on directed acyclic graphs for each variable [21]. The presumptive risk factors of neoadjuvant radiotherapy and defunctioning ileostomy were adjusted for tumour height. Results were presented as risk ratio (RR), 95% CI and P-value.

**Results**

In the QoLiRECT cohort consisting of 1248 patients, 552 patients had an anterior resection, with or without a defunctioning stoma (Fig. 1).

Overall, 433 patients had bowel continuity at 1- or 2-year follow-up and responded to at least one follow-up questionnaire. Patient characteristics are described in Table 1, pretreatment bowel function in Table 2 and treatment related factors in Table 3. Of these, 388 patients (90%) answered all five questions regarding bowel function and were thus available for risk factor analysis and calculation of the LARS score. In the study population, fewer patients were diagnosed with UICC Stage IV disease compared with
LARS in a Scandinavian population

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Figure 1 Flowchart. Out of 1248 patients, 552 were included and operated on with anterior resection, with or without a defunctioning stoma. Seventy-two patients did not respond to any of the follow-up questionnaires. At the first follow-up at 1 year, 361 patients were eligible for analysis, of whom 330 (91%) responded to at least one of the questions regarding bowel function in the questionnaire. At 2 years, the corresponding numbers were 424 eligible patients, of whom 362 (85%) responded to the questionnaire. At 1 year, 119 patients still had a defunctioning stoma. At 2 years, 72 of these patients had been operated on with regained bowel continuity. Nine patients had been operated on with formation of a permanent stoma. Overall, 433 unique patients had bowel continuity at the follow-up at 1 or 2 years and responded to at least one follow-up questionnaire.
patients who had an abdominoperineal excision (APE) or Hartmann’s procedure. Compared with the study population, the 72 patients who did not respond to any of the questionnaires were older, predominantly men and had a higher prevalence of UICC Stage III and IV disease.

Table I Baseline characteristics.

|                              | Patients with rectal cancer, operated with anterior resection | Patients with rectal cancer, not operated with anterior resection* |
|-----------------------------|--------------------------------------------------------------|---------------------------------------------------------------|
| No. of patients             | Study population Missing                                          | Nonresponders Missing Missing                                  |
| No. of patients             | 433                                                    | 72                                                        | 663                                                    |
| Age (years)                 | 66 (25–89)                                               | 70 (42–84)                                                 | 70 (19–95)                                             |
| Sex (female:male)           | 185 (43:248 (57)                                          | 23(32):49(68)                                              | 217(33:446(67)                                          |
| BMI (kg/m²)                 | 25 (16–56)                                               | 25 (19–32)                                                 | 31                                                      |
| Comorbidity                 | Yes                                                      | 253 (60)                                                  | 360 (64)                                               |
| Smoking                     | Current or former smoker                                  | 267 (64)                                                  | 344 (61)                                               |
| Smoking                     | Never smoked                                              | 147 (36)                                                  | 221 (39)                                               |
| Alcohol use                 | More than 16 glasses/week†                                | 9 (2)                                                     | 25 (5)                                                  |
| Alcohol use                 | Fewer than 16 glasses/week†                               | 399 (98)                                                  | 524 (95)                                               |
| Physical activity           | Physically inactive                                       | 38 (9)                                                    | 103 (19)                                               |
| Physical activity           | Light to hard physical activity                           | 366 (91)                                                  | 448 (81)                                               |
| Occupation                  | Working                                                   | 138 (33)                                                  | 31                                                      |
| Occupation                  | Retired                                                   | 251 (61)                                                  | 31                                                      |
| Occupation                  | Unemployed                                                | 5 (1)                                                     | 31                                                      |
| Occupation                  | Sick leave                                                | 21 (5)                                                    | 31                                                      |
| Education                   | University                                                | 97 (23)                                                   | 30                                                      |
| Education                   | Other                                                     | 320 (77)                                                  | 36 (86)                                                |
| Marital status              | In a relationship                                         | 299 (76)                                                  | 399 (73)                                               |
| Marital status              | Not in a relationship                                     | 96 (24)                                                   | 151 (28)                                               |
| ASA grade‡                  | I                                                        | 121 (29)                                                  | 105 (20)                                               |
| ASA grade‡                  | II                                                       | 257 (61)                                                  | 300 (58)                                               |
| ASA grade‡                  | III                                                      | 45 (11)                                                   | 109 (21)                                               |
| ASA grade‡                  | IV                                                       | 2 (1)                                                     | 4 (1)                                                   |
| UICC§                       | 0§                                                       | 8 (2)                                                     | 11 (2)                                                  |
| UICC§                       | I                                                        | 124 (30)                                                  | 154 (29)                                               |
| UICC§                       | II                                                       | 15 (21)                                                   | 154 (29)                                               |
| UICC§                       | III                                                      | 16 (23)                                                   | 106 (20)                                               |
| UICC§                       | IV                                                       | 13 (67)                                                   | 136 (25)                                               |

Values are number of patients unless specified otherwise. Age and body mass index (BMI) are given as median. Percentages or ranges are given in parenthesis.

*Operated with Hartmann’s procedure/abdominoperineal excision/other.
†One glass equals, for example, one glass of wine, 50 cl of beer (3.5%) or 4 cl of liquor (40%).
‡American Society of Anesthesiologists physical status classification system.
§Clinical stage according to The Union for International Cancer Control.
¶Pathological complete response.
Prevalence and the impact on daily life of major LARS

At 1 year, 309 of 330 patients answered all five LARS questions (135 women and 174 men). At 2 years, the figures were 334 of 362 patients (145 women and 189 men). The number of patients with information about LARS at both time points was 255. Out of 99 (39%) patients without major LARS at 1 year, 19 (19%) had major LARS at 2 years. Out of 156 (61%) with major LARS at 1 year, 38 (24%) improved. The statistical comparison between time points is shown in Table 4.

As presented in Fig. 2, the overall prevalence of major LARS was 63% (95% CI 56–69%) at 1 year and 56% (95% CI 50–62%) at 2 years. Younger women had the highest prevalence of major LARS: 69% (95% CI 58–78%) had major LARS at 1 year and 63% (95% CI 52–73%) at 2 years compared with younger men, who had a lowest prevalence of major LARS with 57% (95% CI 46–67%) at 1 year and 56% (95% CI 46–65%) at

### Table 2 Premorbid bowel function.

| Study population (patients operated for rectal cancer with anterior resection) | Missing |
|---|---|
| No. of patients | 433 |
| Frequency of bowel movements |
| Less than once per week | 1 (0) 47 |
| 1–3 times per week | 24 (6) |
| 4–6 times per week | 28 (7) |
| Daily | 159 (41) |
| Several times per day | 174 (45) |
| Leakage |
| No leakage | 365 (92) 37 |
| Leakage | 31 (8) |
| Frequency of leakage |
| Not experienced leakage | 289 (92) 119 |
| Less than once per week | 13 (4) |
| 1–3 times per week | 4 (1) |
| 4–6 times per week | 6 (2) |
| Daily | 2 (1) |
| Several times per day | 0 |
| Bother leakage |
| Not experienced leakage | 279 (72) 47 |
| No bother | 1 (0) |
| Slight bother | 12 (3) |
| Moderate bother | 18 (5) |
| Severe bother | 76 (20) |
| Other bowel dysfunction |
| No | 284 (74) 49 |
| Yes | 100 (26) |
| Preexisting bowel disease |
| No other bowel disease | 402 (96) 15 |
| Inflammatory bowel disease | 1 (0) |
| Irritable bowel syndrome | 5 (1) |
| Other bowel disease | 10 (2) |

Values are number of patients unless specified otherwise. Percentages or ranges are given in parenthesis. In the questions, patients were asked to recall and answer according to their bowel function before the diagnosis of rectal cancer.

### Table 3 Treatment-related factors.

| Study population (patients operated on for rectal cancer with anterior resection) | Missing |
|---|---|
| No. of patients | 433 |
| Tumour height from anal verge (cm)* |
| < 10 | 145 (34) 11 |
| ≥ 10 | 277 (66) |
| Preoperative radiotherapy |
| Yes | 202 (47) 4 |
| No | 227 (53) |
| Preoperative chemotherapy |
| Yes | 58 (14) 4 |
| No | 371 (87) |
| Postoperative chemotherapy |
| Yes | 158 (46) 91 |
| No | 184 (54) |
| Defunctioning stoma |
| Yes | 336 (78) 4 |
| No | 93 (22) |
| If yes, days with stoma (median) | 178 (1–732) 121 |
| With postoperative chemotherapy, days with stoma (median) | 268 (1–732) 89 |
| Without postoperative chemotherapy, days with stoma (median) | 148 (1–560) 81 |
| Anastomotic leakage† |
| Yes | 27 406 |
| Type of anastomosis |
| Reservoir | 210 (69) 128 |
| End-to-end | 95 (31) |
| Operative technique |
| Minimally invasive‡ | 238 (56) 7 |
| Laparotomy | 188 (44) |

Values are number of patients unless specified otherwise. Percentages or ranges are given in parenthesis.

*In Sweden and Denmark a partial mesorectal excision is often performed rather than a total mesorectal excision at a tumour height ≥ 10 cm.

†Anastomotic leakage was only reported in 27 cases, therefore all other cases were considered as missing.

‡Including laparoscopic, robot-assisted and transanal total mesorectal excision.

Prevalence and the impact on daily life of major LARS

At 1 year, 309 of 330 patients answered all five LARS questions (135 women and 174 men). At 2 years, the figures were 334 of 362 patients (145 women and 189 men). The number of patients with information about LARS at both time points was 255. Out of 99 (39%) patients without major LARS at 1 year, 19 (19%) had major LARS at 2 years. Out of 156 (61%) with major LARS at 1 year, 38 (24%) improved. The statistical comparison between time points is shown in Table 4.
2 years. The relative risk for major LARS for younger women versus older women at 2 years was 1.43 (95% CI 1.068–1.909; P = 0.017).

Among younger patients overall there was minor improvement over time, from 63% (95% CI 55–70%) to 59% (95% CI 52–66%). The older patient group had a more equal prevalence of major LARS across sexes and there was more improvement of major LARS between 1 and 2 years, 62% (95% CI 54–69%) to 52% (95% CI 44–60%).

The reported bother decreased from 55% (95% CI 49–61%) at 1 year to 46% (95% CI 40–52%) at 2 years (OR 0.69, 95% CI 0.5–0.96; P = 0.029). The decrease was most noticeable among older men: 57% (95% CI 47–67%) to 42% (95% CI 32–52%) at 2 years (OR 0.53, 95% CI 0.31–0.90; P = 0.019).

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In the reference population, 8% overall (95% CI 6–10%) reported major LARS-like symptoms. Older individuals had a prevalence of major LARS-like symptoms of 9% (95% CI 7–11%) and younger people 8% (95% CI 6–10%). Women had a higher prevalence, 10% (95% CI 7–13%), than men, 6% (95% CI 4–8%); the highest prevalence was noted in older women, at 12% (95% CI 9–16%).

The separate items of the LARS score

The separate items of the LARS questionnaire are displayed in Fig. 3. The two most common symptoms, affecting approximately 90%, were incontinence for flatus and fragmentation/clustering. The prevalence was similar at both 1 and 2 years and there was no difference between the sexes.

The item having the largest impact on the LARS score, ‘Do you ever have such strong urge to open your bowels that you have you rush to the toilet?’, affected approximately 80% of patients both at 1 and 2 years.

About 50% of both men and women reported incontinence for loose stools at both 1 and 2 years, even though this does not score highly in the LARS questionnaire.

In the reference population there was a higher prevalence of bowel dysfunction among women regarding all five items of the LARS score, especially regarding incontinence for flatus and disturbed frequency of bowel movements.

Risk factor analysis

In the risk factor analysis (Table 5), univariate analysis identified preoperative radiotherapy (RR 1.27, 95% CI 1.07–1.50; P = 0.005), defunctioning stoma (RR 1.98, 95% CI 1.45–2.72; P < 0.001) and tumour height (RR 1.15, 95% CI 1.09–1.22; P < 0.001) as possible risk factors for major LARS. Radiotherapy was not significant when the analysis was stratified for tumour height.

A defunctioning stoma was found to be an independent risk factor for major LARS (RR 1.77, 95% CI 1.27–2.46; P < 0.001) after adjusting for tumour height.
Discussion

This study confirms a high prevalence of major LARS in patients who underwent low anterior resection in a Scandinavian setting, and our longitudinal design also shows that there is little improvement after 1 year.

We found a slightly higher prevalence of major LARS in our study population compared with a recent meta-analysis [22]. A possible explanation could be the high proportion of patients with preoperative radiotherapy (47%) and a defunctioning stoma (78%). The time until stoma reversal for patients with adjuvant treatment was longer than for patients without adjuvant treatment (median 268 vs 148 days), so the difference seen may have been the consequence of answering the questionnaire while the bowel was still adapting. Another possibility is that the inactivity of the defunctioned bowel may be of importance. This has been suggested previously, and our data lend support to the idea that patients could be offered an early closure in order to reduce the risk of LARS [23].

The highest prevalence of LARS was noted in younger women. One theory is that women may be more susceptible to LARS due to a prior pelvic floor dysfunction and so physiotherapy may improve
Figure 3 LARS score items. Values within bars are percentages.
In coherence with several other studies [22,25,26], we identified radiotherapy, a defunctioning stoma and tumour height as risk factors in univariate analysis. In adjusted analysis, only a defunctioning stoma remained significant. Unfortunately, due to missing data it was not possible to analyse anastomotic leakage, type of anastomosis and time to stoma closure.

It has previously been thought that bowel adaptation occurs within the first year, after which further improvement is unlikely [27-29]. Recent studies suggest that bowel dysfunction is persistent over time [25,30,31]. Our results support these recent data for the younger population but suggest that some improvement can be seen among older patients. Another interesting observation is that not all patients were bothered by their high LARS score, and that the degree to which they consider the dysfunction problematic decreased over time. This might be explained by disease acceptance or the psychological adaptation that may occur following cancer or other serious illnesses despite persisting functional disturbance [32-34]. The degree of adjustment has been reported to be higher for nonstoma patients than for patients with a stoma after rectal surgery [35]. This is encouraging, and we hope to confirm this in the QoliRECT study which extends to a 5-year follow-up period.

The fact that LARS-like symptoms are present in the general population, as has recently been shown in Denmark, the Netherlands, New Zealand and now also in Sweden, indicates that these are symptoms that are not only related to surgery [9-11]. It also highlights that we may need to reconsider using LARS as the sole evaluation of function after surgery, as a high LARS score in patients before surgery may affect the acceptance of a high LARS score after surgery. It has also been suggested that the LARS score should be combined with a clinical examination as it may overestimate the impact on QoL in some patients and underestimate severe evacuatory dysfunction [36].

A strength of this study is the longitudinal prospective design, enabling exploration of bowel function over time, and also that there is a reference population. The number of patients is also a strength, as well as the high response rate. The availability of data on premorbid bowel function and preoperative leakage as a measurement of sphincter function is also a strength and points out the difficulty of using preoperative function as an indicator for the risk of postoperative LARS in terms of recall bias. We lack preoperative data on the prevalence of LARS-like symptoms. However, given that patients

### Table 5 Risk factor analysis.

| Potential risk factor | LARS | Univariate analysis | Multivariate analysis |
|-----------------------|------|---------------------|----------------------|
|                       | Category | No/minor (n = 163) | Major (n = 225) | Missing | Comparisons | RR (95% CI) | P-value | RR (95% CI) | P-value | Missing |
| Sex                   | Men    | 96 (44)            | 123 (56)          | 0        | Women vs men | 1.08       | 0.405    |          |          |          |
|                       | Women  | 67 (40)            | 102 (60)          | 0        |           | (0.91–1.27) |          |          |          |
| Preoperative radiotherapy* | No    | 101 (48)        | 109 (52)          | 2        | Yes vs no | 1.27     | 0.005    | 1.07    | 0.271    | 10      |
|                       | Yes    | 60 (34)            | 116 (66)          | 0        |           | (1.07–1.50) |          | (0.95–1.20) |          |          |
| Preoperative chemotherapy | No    | 146 (43)        | 193 (57)          | 2        | Yes vs no | 1.20     | 0.105    |          |          |          |
|                       | Yes    | 15 (32)            | 32 (68)           | 0        |           | (0.96–1.48) |          |          |          |
| Postoperative chemotherapy | No    | 70 (42)         | 97 (58)           | 82       | Yes vs no | 1.08     | 0.421    |          |          |          |
|                       | Yes    | 52 (37)            | 87 (63)           | 0        |           | (0.90–1.29) |          |          |          |
| Preoperative sphincter dysfunction/leakage | No    | 140 (42)        | 190 (58)          | 30       | Yes vs no | 1.18     | 0.235    |          |          |          |
|                       | Yes    | 9 (32)             | 19 (68)           | 0        |           | (0.90–1.55) |          |          |          |
| Defunctioning stoma* | Yes    | 104 (35)          | 196 (65)          | 3        | Yes vs no | 1.98     | < 0.001  | 1.77    | < 0.001  | 11      |
|                       | No     | 57 (67)            | 28 (33)           | 0        |           | (1.45–2.72) |          | (1.27–2.46) |          |          |
| Age (years)           | Median (Q1;Q3) | 67 (60–73)   | 66 (60–72)        | 0        | 10-year increase | 0.96 | 0.292    |          |          |          |
|                       |         | (9–14)             | (10–12)           | 8        | (0.89–1.04) |          |          |          |
| Tumour height (cm)    | Median (Q1;Q3) | 12 (9–14)    | 10 (8–12)         | 8        | 2 cm decrease | 1.15 | < 0.001  |          |          |          |
|                       |         | (9–14)             | (10–12)           | 8        | (1.09–1.22) |          |          |          |

Values are numbers of patients unless specified otherwise. Percentages or ranges are given in parenthesis.

*Adjusted for tumour height in multivariate analysis.
often present with impaired bowel function due to their rectal tumour, this is almost impossible to achieve.

A weakness is that we used more response options than the original LARS score, although they were able to be translated entirely into the LARS score. Extended response options were used throughout the questionnaires as some authors suggest that offering additional options enables patients to find the answer most compatible with their situation [17,37].

In conclusion, there is a high and persisting prevalence of major LARS at 1 and 2 years after surgery, with younger patients, especially younger women, being the patient group most affected. Although there seems to be an adaptation in terms of decreasing bother over time, these patients must be informed that their risk for major LARS is high and perhaps they should be prioritized for an early stoma closure to improve their chances of a more normal bowel function in the future.

Conflict of interest

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Supporting Information

Additional Supporting Information may be found in the online version of this article:
Appendix S1. Questions on bowel function used in the QoLiRECT questionnaires.