Predictive model estimating the decrease of postoperative gastrointestinal quality of life index (GIQLI) in patients after elective laparoscopic sigmoid resection for diverticular disease

Alberto Posabella 1,2 · Daniel Christian Steinemann 1,2 · Raoul André Droeser 1 · Nadshatra Varathan 1 · Selin Göksu Aycıçek 2 · Fabio Nocera 1 · Markus von Flüe 1 · Niccolò Rotigliano 1 · Ida Füglistaler 1

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Abstract
Background Growing consider in quality of life (QoL) has changed the therapeutic strategy in patients suffering from diverticular disease. Patients’ well-being plays a crucial role in the decision-making process. However, there is a paucity of studies investigating patients’ or surgery-related factors influencing the postoperative gastrointestinal function. The aim of this study was to investigate in a predictive model patients or surgical variables that allow better estimation of the postoperative gastrointestinal QoL.

Methods This observational study retrospectively analyzed patients undergoing elective laparoscopic sigmoidectomy for diverticulitis between 2004 and 2017. The one-time postoperative QoL was assessed with the gastrointestinal quality of life index (GIQLI) in 2019. A linear regression model with stepwise selection has been applied to all patients and surgery-related variables.

Results Two hundred seventy-two patients with a mean age of 62.30 ± 9.74 years showed a mean GIQLI of 116.39 ± 18.25 at a mean follow-up time of 90.4 ± 33.65 months. Women (n=168) reported a lower GIQLI compared to male (n=104; 112.85 ± 18.79 vs 122.11 ± 15.81, p<0.001). Patients with pre-operative cardiovascular disease (n=17) had a worse GIQLI (106.65 ± 22.58 vs 117.08 ± 17.66, p=0.010). Finally, patients operated less than 5 years ago (n=63) showed a worse GIQLI compared to patients operated more than 5 years ago (n=209; 111.98 ± 19.65 vs 117.71 ± 17.63, p=0.014).

Conclusions Female gender and the presence of pre-operative cardiovascular disease are predictive for a decreased postoperative gastrointestinal QoL. Furthermore, patients’ estimation of gastrointestinal functioning seems to improve up to 5 years after surgery.

Keywords Laparoscopic sigmoid resection · Gastrointestinal quality of life · GIQLI · Bowel function · Linear regression model

Introduction
During the last decades, there is a growing attention to the quality of life (QoL) of patients after abdominal surgery, particularly in those suffering from diverticular disease [1, 2]. Recently the guidelines on the treatment of diverticulitis have changed in particular concerning the role of the surgery. If previously the number of diverticulitis episodes represented one of the main criteria to decide for sigmoidectomy, nowadays the patient’s well-being and more generally their QoL play a crucial role in that decision-making process [2–4]. Hence, the treatment of uncomplicated diverticulitis has evolved to a tailored approach, and a major consideration has been given to the evaluation of their gastrointestinal symptoms [3–5].

Confirmed by recent literature, patients undergoing elective laparoscopic sigmoid resection for diverticulitis report an improvement in their gastrointestinal symptoms compared to those treated conservatively [6–8]. Unfortunately, previous studies did not assess in detail patients’ related demographic data (as age, sex, pre-operative comorbidities, indication for surgical treatment), intraoperative variables (such as kind of...
anastomosis, vascular approach to the inferior mesenteric artery, conversion to laparotomy, use of drainage), and postoperative morbidity on gastrointestinal QoL.

Thus, the purpose of the current study was to evaluate the gastrointestinal QoL after elective laparoscopic sigmoid resection using the gastrointestinal quality of life index (GIQLI). The GIQLI is a 36-item gastrointestinal-specific questionnaire designed to assess, in clinical practice, the gastrointestinal function of patients [9]. Although focusing on the core gastrointestinal symptoms, four other different subdomains (physical, psychological, social, and disease-specific items) widely investigate different aspects of the QoL of the patients [9]. All different subdomains explored by the GIQLI were assessed as well as potential risk factors for a decreased postoperative GIQLI. Our attention was focused to elucidate any predictive role of the variables analyzed.

Methods

Study design

Data were retrospectively collected from patients undergoing elective laparoscopic sigmoid resection for diverticular disease between 2004 and 2017 at the St. Clara Hospital in Basel, Switzerland.

Patients undergoing an emergency or a primary open resection were excluded. Data collected comprise patient’s demographic, pre-operative comorbidities, intraoperative surgical technique, postoperative morbidity, and mortality at 30 days.

Thus, in 2019 the 36-item gastrointestinal quality of life index (GIQLI) was sent by mail to all eligible patients to collect their postoperative outcomes according to the Table S1 (see supporting information) [9]. Along with the questionnaire, a patient information letter explaining the purpose of the study and a written informed consent were enclosed. Patients who did not return the survey despite our reminder phone call, or those who did not agree to participate, or those who deceased prior to the time of the assessment were excluded from the study.

Patients who successfully completed and returned the questionnaire were also contacted by telephone by the same investigator to assess actual comorbidities and possible subsequent abdominal surgery in the time frame between sigmoid surgery and survey. In particular, patients under regular medication for gastrointestinal tract diseases as well as patients who underwent surgery on the upper or lower GI tract affecting the intestinal function were excluded from the final analysis.

Finally, a linear regression model with stepwise selection has been applied to all data analyzed from this population in order to find the best predictive combination of variables to estimate the postoperative GIQLI.

The study was conducted in compliance with the current version of the Declaration of Helsinki and was approved by the ethics committee of the Northwestern and Central Switzerland (EKNZ 2018-00318).

Surgical technique

To rule out malignancy, all patients had a pre-operative colonoscopy at least 2 weeks before the surgical procedure. The day before the intervention, mechanical bowel preparation and a thrombotic prophylaxis was performed. By induction of general anesthesia, antibiotic prophylaxis was given and repeated, if necessary, every 4 h (metronidazole 500 mg iv and cefuroxime 2 g iv). Once the CO2 pneumoperitoneum was established, the laparoscopic procedure began with the dissection of the gastrocolic ligament to reach a complete mobilization of the splenic flexure. According to the twelve involved surgeon’s preferences, the vascular approach to the IMA was distinguished between central or peripheral ligation. In the first case, the inferior mesenteric vein was firstly identified at the inferior pancreatic margin close to the Treitz ligament and sectioned between clips. The IMA was detected at its origin from the aorta (“high tie”) and transected with a vascular stapler (Endo GIA™ 30/45-mm Articulating Vascular/Medium Reload with TriStaple™ Technology, Covidien) after routine identification and preservation of the autonomic nerves of the superior hypogastric plexus.

On the contrary, in the peripheral ligation of the IMA, the mesentery dissection was performed close to the colonic wall sparing the left colic artery as well as the superior rectal artery.

Finally, the colon was then transected with a linear stapler (Endo GIA™ 45/60-mm Articulating Medium/Thick Reload with Tri-Staple™ Technology, Covidien), and the colorectal anastomosis, when applicable, was performed trans-anally in a double stapling technique. The side-to-end anastomosis was considered the first choice, while the side-to-side and the end-to-end anastomosis were only performed in particular intraoperative conditions (e.g., lack of adequate length for anastomosis). The sigmoid specimen was retracted through a Pfannenstiel incision or enlargement of the left lower abdominal incision.

Outcome measurements

The one-time postoperative QoL was assessed with the gastrointestinal quality of life index (GIQLI) [9]. This is a validated gastrointestinal QoL questionnaire consisting of 36 questions investigating the core gastrointestinal symptoms as well as physical, psychological, social, and disease-specific issues. Each question has a score ranking from 0 (worst) to 4 (best). The maximal obtainable score is 144, reflecting an optimal QoL without any symptoms, as described in Table S1 (see supporting information).
With the aim to assess the later developed comorbidities, we conducted a telephone survey using the Self-Administered Comorbidity Questionnaire (SCQ), a questionnaire of a self-administered measure of comorbidity validated for clinical and health services research settings [10]. This questionnaire is particularly useful because of its understandability and shortness giving us the possibility to assess in a concise and comprehensive manner the comorbidities of our study population as summarized in Table S2 (see supporting information). The questionnaire includes 12 medical conditions; through three “yes” or “no” questions, the score ranges between 0 (no pathology) and 3 (condition limiting the daily activity). To minimize an interviewer bias, the telephone survey was performed by the same investigator, following a standardized approach, ensuring the total anonymity to the other investigators who would subsequently conduct the statistical analysis of the results. This score allowed us to identify any possible significant comorbidity developed, along our population, between the surgery and the survey [10].

Statistical analysis

A linear regression was trained with stepwise model selection by Akaike information criterion (AIC) using the caret package in R statistical software. A 10-fold cross-validation was used to estimate the residual mean squared error (RMSE). A two-tailed $t$ test was used to estimate the significance of each variable. $P$-values < 0.05 were considered statistically significant.

Continuous data were expressed as the mean ± standard deviation or median and range as indicated. Correlation between GIQLI and other variables was assessed with Pearson’s coefficients.

Results

During the study period, 392 of 1213 patients undergoing to elective laparoscopic sigmoid resection for diverticular disease were enrolled in the study. Among these 392 patients, 277 filled the survey out correctly and answered to our subsequent SQC survey. After a stratification of different developed comorbidities, five patients were excluded from the final analysis: three due to their subsequent diagnosis of inflammatory bowel disease and two because they underwent additional abdominal surgery as described in the Fig. 1.

A baseline comparison between the 705 hypothetic eligible patients and the final 272 patients considered is summarized in Table S3 (see supporting information).

All demographic data at time of surgery, the pre-operative and intraoperative variables, as well as the postoperative morbidity of the eligible and included patients are listed in Table 1. The mean GIQLI of all the 272 patients was 116.39±18.25, while the mean follow-up time was 90.4 ± 33.65 months.

The principal component analysis (PCA) of this cohort clustered patients in three main groups with similar characteristics, showing the relationship between these variables and the GIQLI as visualized in Fig. 2.

According to the linear regression model with stepwise selection, the gender, the time frame between the surgical procedure and our survey, and a pre-operative cardiovascular disease represent the conditions to better predict a decreased GIQLI (coefficient $-2.369e-05$, $1.355e-01$, and $-1.413e-01$, respectively).

The female population (168 patients) showed a lower GIQLI compared to male (104 patients; 112.85±18.79 vs 122.11±15.81, $p<0.001$).

In addition, the comparison between both groups did not show any difference in terms of demographic and perioperative data, except for a predominance of history of previous operations in women and an intraoperative performed side-to-side anastomosis (51.7% vs 27.9%, $p<0.001$ and 11.3% vs 2.8%, $p=0.012$, respectively) as summarized in the Table 2. Nevertheless, the analysis of female subpopulations made by women with or without history of previous surgery confirms lower gastrointestinal quality of life index compared to male (87 patients; 111.89±19.62 vs 122.11±15.81, $p<0.001$, and 81 patients; 113.88±17.92 vs 122.11±15.81, $p<0.001$). In addition, the assessment of further actual comorbidities trough the telephonic survey of the Self-Administered Comorbidity Questionnaire (SCQ) showed no significant differences in the incidence of comorbidities along both groups (women: 83.3% vs men: 74.1%, $p=0.063$) excluding the prevalence of kidney disease in female population compared to the male one ($p=0.042$) (Table 2). A subsequent cross-comparison between all 5 different domains of the survey along both groups showed a significant worse GIQLI score in women compared to men, particularly among the subdomain core symptoms and disease-specific and psychological items as summarized in Table 3.

Moreover, no statistical difference in terms of GIQLI score has been noticed among 40 patients (14.7%) that developed postoperative complications compared to those with an uneventful postoperative course (232 patients; 112.98 ± 23.83 vs 116.97 ± 17.10, $p=0.100$).

Patients with a pre-operative cardiovascular disease (17 patients) had as well lower GIQLI compared to others (255 patients; 106.65 ±22.58 vs 117.08±17.66, $p=0.010$).

Finally, the GIQLI score improves progressively over the time. In fact, patients that underwent sigmoid resection more than 5 years before follow-up (209 patients) had a better GIQLI compared to the patients that underwent surgery less than 5 years ago (63 patients; 117.71±17.63 vs 111.98±19.65, $p=0.014$). More in detail, a selected comparison between patients operated within 5 years (63 patients) vs patients operated between 6 and 9 years ago (137 patients) or vs patients operated more than 10 years ago (72 patients) showed always
a worse GIQLI in the first 5 years after surgery (111.98±19.65 vs 117.31±18.20, \( p = 0.031 \) and 111.98±19.65 vs 118.49±16.60, \( p = 0.019 \), respectively). On the contrary, no difference has been reported among patients operated between 6 and 9 years ago compared to those operated more than 10 years ago (117.31±18.20 vs 118.49±16.60, \( p = 0.323 \)).

Finally, the vascular approach to the IMA (central vs peripheral ligation) did not have any impact on the postoperative GIQLI (116.38±18.19 vs 116.39±18.53, \( p = 0.498 \)).

**Discussion**

The current study investigated the long-term outcome of gastrointestinal function after elective laparoscopic sigmoid resection for diverticular disease in 272 patients. It demonstrated that female gender and the presence of pre-operative cardiovascular disease were predictive for a decreased postoperative GIQLI. Furthermore, a time lag below 5 years after surgery was associated with a lower gastrointestinal functioning compared to a longer follow-up. On the other hand, central dissection of the IMA using a high tie versus peripheral mesenteric dissection did not influence the long-term GIQLI.

In the last years, the guidelines on the treatment of diverticulitis have changed their recommendations, and the role of surgery has now evolved to a tailored approach focusing on the well-described improvement of gastrointestinal symptoms [11–14]. Despite this change in daily practice, to date few studies have deeply analyzed whether any patients or surgery-related variables could estimate the postoperative GIQLI. The knowledge of risk factors for poor gastrointestinal functioning after surgery could be thus of importance in the decision-making for elective surgery in chronic diverticular disease.

Forgione et al. compared the pre-operative and postoperative GIQLI in a small group of patients showing an increase of 10 points in patients undergoing to sigmoid resection. With a mean GIQLI of 111.5±20.4, 12 months after surgery, the score was in the same range as in the current study. The study by Forgione et al. confirmed the benefit of a surgical intervention, most of all in the improvement of disease-specific subdomain, but, unfortunately, the authors did not investigate any predictive variable responsible for this positive result [3, 5].

Through an exploratory principal component analysis, we have identified three main clusters of patients with similar characteristics. The cluster with the largest number of patients is mainly composed by young patients, with low frequency of
pre-operative comorbidities that underwent surgery for recurrent diverticulitis. Those patients did not present postoperative morbidity. The second most populous cluster was represented by older patients, with pre-operative risk factors, who have benefited from a resection with preservation of the IMA.

Finally, the third cluster is represented by the more complex cases, where the indication for surgery was due to a diagnosis of covered perforation or stenosis requiring, in the most of cases, a side-to-side anastomosis or temporary stoma.

This stratification of the cohort allowed confirming the heterogeneity of our population, showing that the QoL results were equally distributed in all three main clusters, thus excluding any possible selection bias in our further analysis.

A following linear regression model with stepwise selection allowed identifying the best predictive model, including the most influential variables, to achieve a good estimation of postoperative GIQLI. Interestingly, we noted that patients with previous cardiovascular disease and, most important, women had a significant worse postoperative GIQLI. By comparing in detail each answer of the assessment, we found that in 4 out of 5 different domains investigated, women consistently had a lower QoL compared to men, especially considering the core symptoms, the disease-specific and the physical and psychological items. This result seems to be independent of the higher rate of previous surgery in women. The analysis of sub-populations made by women with or without history of previous surgery confirmed lower GIQLI compared to male. The most significant differences indicate that in particular, abdominal pain, abdominal bloating with flatulence, and fecal urgency are the most crucial parameters negatively influencing the QoL. In literature, this aspect has been rarely investigated. Levack et al. retrospectively confirmed the results of the current analysis showing in his logistic regression analysis that high rates of fecal incontinence, fecal urgency, and also incomplete emptying after the sigmoid resection were predicted by female sex [8].

As already described in other studies, we also confirmed the tendency that over the time there is an improvement in the GIQLI [3, 5, 6]. In particular, within 5 years of surgery, the mean GIQLI was lower when compared with patients undergoing surgery more than 5 years ago. According to consistent literature, the general improvement over time of the GIQLI is probably due to biologic compensating mechanisms or, maybe together, to a psychological patient’s adaption to the surgical procedure and its postoperative outcomes [15, 16].

Interestingly, in the current analysis, central dissection of the IMA or peripheral mesenteric dissection did not influence the long-term GIQLI. Actually, the Italian Society of Colon and Rectal Surgery as well as the German Society of Colorectal disease recommend that the central ligation of IMA should be reserved in cases of suspected malignant disease or when the achieved colon mobilization is not enough to

### Table 1

|                               | 2004–2017 | 2004–2017 |
|-------------------------------|-----------|-----------|
| Number                        | 392       | 272       |
| Sex male/female               | 148 (37.7%)/244 (62.3%) | 104 (38.2%)/168 (61.8%) |
| Age, mean ± standard deviation years | 61.82 ± SD 10.22 | 62.30 ± SD 9.74 |
| Pre-OP comorbidities          | 131 (33.4%) | 87 (31.9%) |
| Immunosuppression             | 1         | 1         |
| Diabetes mellitus             | 21        | 13        |
| Coronal disease               | 29        | 17        |
| Hypertension                  | 108       | 72        |
| History previous operations   | 172 (43.9%) | 116 (42.6%) |
| Recurrent diverticulitis      | 344 (87.8%) | 237 (87.1%) |
| Recurrent diverticulitis with covered perforation | 34 (8.7%) | 27 (9.9%) |
| Diverticular disease with enterovaginal fistula | 1 (0.2%) | 0 |
| Diverticular disease with enterovesical fistula | 2 (0.5%) | 2 (0.8%) |
| Stenosing diverticular disease | 11 (2.8%) | 6 (2.2%) |
| Conversion laparotomy         | 27 (6.9%) | 20 (7.3%) |
| Use of drains                 | 215 (54.8%) | 145 (53.3%) |
| IMA preserved                 | 265 (67.6%) | 201 (73.9%) |
| IMA resected                  | 127 (32.4%) | 71 (26.1%) |
| Anastomosis S-E               | 324 (82.6%) | 219 (80.5%) |
| Anastomosis E-E               | 32 (8.2%) | 24 (8.8%) |
| Anastomosis S-S               | 29 (7.4%) | 22 (8.1%) |
| Anastomosis not applicable    | 7 (1.8%) | 7 (2.6%) |
| Complications                 | 69 (17.6%) | 40 (14.7%) |
have a tension-free anastomosis [17, 18]. In the literature, the influence of a high tie dissection of the IMA on QoL was mostly studied in colorectal surgery for cancer [19–22]. The hypothesis by which the oncological resection could influence the postoperative QoL is based on anatomical reasons. The sympathetic nervous system originating from the inferior mesenteric plexus and the parasympathetic nervous system originating from the pelvic plexus innervate the descending and sigmoid colon, and they could be damaged during the mesorectum plane dissection or central ligation of the IMA [23, 24]. Moreover, a sacrifice of the IMA could result in ischemia with consequently higher short-term complications or later anastomosis stenosis, and these scenarios could also be reflected in persisting or new onset of gastrointestinal symptoms [2, 4, 7, 10]. Unfortunately, few authors have evaluated the same risk in patients undergoing sigmoid resection for diverticular disease. The available studies concerning preservation or resection of the IMA in diverticular disease showed contradictory results. While Masoni et al. and Dobrowolski et al. reported a lower incidence of defecation disorders, fecal incontinence, and a greater QoL score in patients undergoing to IMA-preserved resection, Mari et al. demonstrated no differences between these different vascular approaches at 1 and 9 months after surgery [25–27]. Finally, our study, with a mean follow-up time of 90.4 ± 33.65 months, adds important evidence to the literature that the type of IMA ligation (central vs peripheral) does not represent a predictive estimator of the GIQLI.

The present study is inherently limited by its retrospective nature and a unique time-point assessment. First, the high drop-off rate, as described in table S3, represents an important
limitation to notice. Secondly, the follow-up was assessed by questionnaires and not through a face-to-face interview with, if necessary, a clinical examination, influencing the quality of data collected. Moreover, according to the study design and the long follow-up, the lack of pre-operative GIQLI critically mitigates our conclusion.

Keeping this weakness in mind, the clinical relevance of the results must be interpreted with caution. In particular, even if the analysis of female sub-populations, with or without previous history of surgery, consistently present a lower GIQLI compared to male, this difference needs to be carefully interpreted before applying in the decision-

### Table 2 Comparison of all the demographic data along the female and male population, including the Self-Administered Comorbidity Questionnaire (SQC) results

|                                    | Women | Men   | P value |
|------------------------------------|-------|-------|---------|
| Number                             | 168   | 104   |         |
| Age, years average ± SD            | 63.04±9.75 | 61.11±9.64 | 0.055  |
| Time to operation, average months ±SD | 90.36±34.67 | 90.46±31.12 | 0.490  |
| Pre-OP comorbidities               |       |       |         |
| Immunosuppression                  | 0     | 1 (0.9%) | 1       |
| Diabetes mellitus                  | 6 (3.6%) | 7 (6.7%) | 0.253  |
| Coronary disease                   | 11 (6.5%) | 6 (5.8%) | 1       |
| Hypertension                       | 41 (24.4%) | 31 (29.8%) | 0.326  |
| History previous operations        | 87 (51.7%) | 29 (27.9%) | <0.001 |
| Recurrent diverticulitis           | 150 (89.2%) | 87 (83.6%) | 0.195  |
| Recurrent diverticulitis with covered perforation | 13 (7.7%) | 14 (13.6%) | 0.290  |
| Diverticular disease with enterovaginal fistula | 0 | 0 | n.a. |
| Diverticular disease with enterovesical fistula | 2 (1.2%) | 0 | 0.525  |
| Stenosing diverticular disease     | 3 (1.9%) | 3 (2.8%) | 0.677  |
| Conversion laparotomy              | 12 (7.1%) | 8 (7.7%) | 1       |
| Use of drains                      | 89 (52.9%) | 56 (53.8%) | 0.901  |
| IMA preserved                      | 120 (71.4%) | 81 (77.9%) | 0.258  |
| IMA resected                       | 48 (28.6%) | 23 (22.1%) |         |
| Anastomosis S-E                    | 132 (78.6%) | 87 (83.6%) | 0.346  |
| Anastomosis E-E                    | 12 (7.1%) | 12 (11.7%) | 0.271  |
| Anastomosis S-S                    | 19 (11.3%) | 3 (2.8%) | 0.012  |
| Anastomosis not applicable         | 5 (3%) | 2 (1.9%) | 0.711  |
| Complications                      | 25 (14.9%) | 15 (14.4%) | 1       |
| SQC scores*                        |       |       |         |
| Number of patients (%)             | 140 (83.3%) | 77 (74.1%) | 0.063  |
| Comorbidities, mean score          |       |       |         |
| Heart disease                      | 0.27  | 0.38  | 0.116  |
| Blood pressure                     | 0.86  | 0.88  | 0.412  |
| Lung disease                       | 0.15  | 0.1   | 0.169  |
| Diabetes                           | 0.06  | 0.13  | 0.072  |
| Ulcer/stomach disease              | 0.32  | 0.22  | 0.132  |
| Kidney disease                     | 0.05  | 0     | 0.042  |
| Liver disease                      | 0.01  | 0     | 0.216  |
| Anemia other blood disease         | 0.08  | 0.12  | 0.274  |
| Cancer                             | 0.04  | 0.02  | 0.235  |
| Depression                         | 0.12  | 0.06  | 0.125  |
| Degenerative arthritis             | 0.15  | 0.1   | 0.169  |
| Back pain                          | 0.14  | 0.07  | 0.085  |
| Rheumatoid arthritis               | 0.08  | 0.04  | 0.158  |
| Others                             | 0.74  | 0.64  | 0.069  |

Significant differences are highlighted in bold

*SQC score ranges between 0 (no pathology) and 3 (condition limiting the daily activity)
Table 3 Sub-analysis of all the 5 different GIQLI domains and relative 36 specific questions applied to the female (n=168) and male (n=104) population

| Domain                                  | Women          | Men            | P value |
|-----------------------------------------|----------------|----------------|---------|
| Core symptoms                           |                |                |         |
| Abdominal pain                          | 2.89±1.07      | 3.44±0.91      | <0.001  |
| Feeling of abdominal fullness           | 2.78±1.08      | 3.31±0.84      | <0.001  |
| Abdominal bloating (too much gas)       | 2.40±1.13      | 2.92±0.99      | <0.001  |
| Trouble with flatulence                 | 2.48±1.12      | 2.93±1.01      | <0.001  |
| Trouble with burping or belching        | 3.23±0.97      | 3.28±0.92      | 0.356   |
| Trouble with gurgling abdominal noises  | 3.07±0.93      | 3.27±0.77      | 0.036   |
| Trouble with bowel frequency            | 2.84±1.09      | 3.34±0.95      | <0.001  |
| Enjoyed eating                          | 3.40±0.84      | 3.48±0.82      | 0.213   |
| Need for restricted eating              | 3.01±0.94      | 3.43±0.87      | <0.001  |
| Trouble with fatigue                    | 2.53±0.92      | 2.85±0.94      | 0.003   |
| Total score                             | 28.36±6.80     | 32.18±5.71     | <0.001  |

| Psychological items                     |                |                |         |
| Coping with every day stress            | 3.00±0.81      | 3.18±0.80      | 0.036   |
| Sadness about illness                   | 3.50±0.84      | 3.69±0.64      | 0.024   |
| Nervousness or anxious about illness    | 3.50±0.74      | 3.68±0.66      | 0.022   |
| Happiness with life in general          | 3.28±0.69      | 3.29±0.97      | 0.474   |
| Frustration about illness               | 3.48±0.83      | 3.71±0.59      | 0.006   |
| Total score                             | 16.73±3.03     | 17.52±2.56     | 0.013   |

| Physical items                          |                |                |         |
| Feeling unwell                          | 2.89±0.89      | 3.23±0.85      | <0.001  |
| Wake-up at night                        | 1.54±1.50      | 2.28±1.44      | <0.001  |
| Trouble with changes in appearance      | 3.49±0.82      | 3.69±0.75      | 0.021   |
| Loss of physical strength               | 3.27±0.90      | 3.38±0.93      | 0.151   |
| Loss of endurance through illness       | 3.32±0.86      | 3.38±0.93      | 0.279   |
| Feeling unfit                           | 3.19±1.00      | 3.30±0.96      | 0.175   |
| Total score                             | 17.37±4.37     | 19.12±4.44     | <0.001  |

| Social items                            |                |                |         |
| Coping with daily activities            | 3.73±0.71      | 3.87±0.34      | 0.037   |
| Taking part in leisure activities       | 3.34±1.15      | 3.41±0.84      | 0.280   |
| Bothered by medical treatment           | 3.72±0.64      | 3.76±0.59      | 0.286   |
| Trouble of personal relationship        | 3.65±0.69      | 3.75±0.63      | 0.123   |
| Sexual life impairment                  | 3.53±0.95      | 3.21±1.17      | 0.007   |
| Total score                             | 17.18±3.66     | 17.79±2.58     | 0.068   |

| Disease-specific items                  |                |                |         |
| Regurgitation                           | 3.56±0.81      | 3.60±0.78      | 0.356   |
| Trouble with slow speed of eating       | 3.73±0.63      | 3.80±0.56      | 0.180   |
| Trouble with dysphagia                  | 3.74±0.59      | 3.78±0.64      | 0.323   |
| Trouble with bowel urgency              | 2.71±1.02      | 3.17±0.92      | <0.001  |
| Trouble with diarrhea                   | 2.99±0.97      | 3.34±0.85      | 0.001   |
| Trouble with constipation               | 2.87±1.13      | 3.37±0.86      | <0.001  |
| Trouble with nausea                     | 3.54±0.72      | 3.72±0.61      | 0.017   |
| Trouble with blood in stool             | 3.94±0.28      | 3.86±0.45      | 0.042   |
| Trouble with heartburn                  | 3.22±1.02      | 3.29±0.92      | 0.280   |
| Trouble with incontinence               | 3.33±0.94      | 3.65±0.68      | 0.001   |
| Total score                             | 33.41±5.02     | 35.50±4.29     | <0.001  |

Significant differences are highlighted in bold.
making process. In fact, a single time-point used to assess
the postoperative gastrointestinal function without pre-
optative time-point cannot deeply investigate this factor
and its liability along the GIQLI score.

Finally, developing a postoperative complication does not
seem to decrease the gastrointestinal quality of life, but this
result must be interpreted with caution due to the lack of more
specific data.

For all these reasons, we are considering applying our pre-
dictive model in a prospective study to verify the liability and
the power of our results. Interestingly a protocol for a similar
prospective, multicenter, and trans-national observational
study has been recently published; the authors aim at identi-
fying predictors of a postoperative change in quality of life
in patients, comparing different surgical approaches [28].

Conclusion

In conclusion, this observational study with a long-term fol-
low-up of patients undergoing elective laparoscopic sigmoid
resection for diverticular disease identified possible predictors
of a decreased gastrointestinal QoL. Interestingly, female gen-
der and the presence of cardiovascular disease seem to be the
most predictive variables for poor postoperative QoL, while
patients’ estimation of gastrointestinal functioning seems to
improve over the time. However, current recommendation of
different national surgical societies to preserve the IMA in
order to maintain gastrointestinal function was not confirmed
by the findings in the present trial. The preservation or resec-
tion of the IMA had no influence on the GIQLI in this study.

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pretation of data, and drafting of manuscript. RA Droeser: study concep-
tion and design and critical revision of the manuscript. N. Varathan: study
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Declarations

Ethics approval The study was conducted in compliance with the cur-
cent version of the Declaration of Helsinki and was approved by the local
ethical committee of Nordwestschweiz.

Consent to participate Informed consent was obtained from all individ-
ual participants included in the study.

Consent to publish Patients signed informed consent regarding publish-
ing their data.

Conflict of interest The authors declare no competing interests.

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