

# Health-related quality of life and functional disorders after diverticular surgery

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Ther Adv Gastroenterol

2022, Vol. 15: 1–18

DOI: 10.1177/  
17562848211066437

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**Abstract:** Diverticulosis and diverticulitis are leading indications for colorectal surgery in Western countries. Abdominal pain, functional disorders, and low health-related quality of life (HRQoL) can limit the outcome of abdominal surgery even in the absence of complications. Therefore, we aimed to review current evidence on postoperative long-term outcomes including HRQoL, functional disorders, abdominal pain, and patients' satisfaction after diverticular surgery for diverticulosis/diverticulitis. We performed a PubMed database search (inception: 17 December 2020). Identified publications were screened and outcome parameters extracted. In summary, HRQoL increased after diverticular surgery in 9 out of 10 longitudinal cohort studies. Similarly, patients' satisfaction with treatment and their choice to undergo surgery was commonly reported as high or very good, as reported in eight studies. In a randomized control trial and retrospective cohort, elective diverticular surgery was superior to conservative treatment regarding HRQoL. In cross-sectional analyses, chronic abdominal pain and functional disorders including defaecation disorders or diarrhoea/obstipation were found in a relevant fraction of patients. Incontinence ranged from 5% to 25% with insufficient data for comparison before and after surgery. However, functional disorders did not result in decreased HRQoL in most studies, and no increase in functional disorders was observed after elective diverticular surgery in longitudinal analyses. We conclude that HRQoL among operated patients with diverticular disease improved in most studies after surgery. Functional disorders and postoperative abdominal pain can be present after elective diverticular surgery; however, no increase in functional disorders was observed in longitudinal studies. Functional disorders after diverticular surgery need to be carefully discussed with the patient before surgery and a careful clinical assessment before surgery including incontinence scoring should be considered.

**Keywords:** abdominal pain, diverticular disease, functional gastrointestinal diseases, surgery

Received: 23 July 2021; revised manuscript accepted: 24 November 2021.

## Introduction

Colon diverticulosis and diverticulitis are common diseases affecting patients in developed countries and remain a frequent indication for colorectal surgery.<sup>1</sup> Only 5% of the population younger than 40 years are affected by diverticular disease, whereas this number rises to up to 65% among individuals older than 65 years.<sup>2,3</sup> The number of patients treated for diverticulitis has been increasing in the last decades in parallel with increasing age in Western populations.<sup>4</sup>

Most patients with diverticulosis remain asymptomatic and only a subset of about 10–20% of patients will develop symptoms of diverticulitis, such as left-sided abdominal pain, fever, chills or altered stool frequency.<sup>5</sup> Although diverticulitis has an increased risk of recurrence, complicated courses after recovery from an uncomplicated episode are rare and do not seem to be influenced by younger age or two or more previous episodes.<sup>6</sup> However, chronic symptoms were found to persist in 5–22% of patients despite uneventful surgical

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resection. Thus, recommendations for elective surgical treatment of diverticulitis have been shifting from a strict scheme based on the number of previous attacks to a more personalized patient-based approach, considering multiple parameters, such as burden of disease, patient preference, ongoing symptoms and predicted health-related quality of life (HRQoL) after surgery.<sup>4,6,7</sup>

When balancing the risks and benefits of elective diverticular surgery, considerations regarding long-term outcomes are crucial. Therefore, the aim of this literature review was to summarize available evidence on postoperative HRQoL, functional disorders and pain after diverticular surgery for diverticulitis or symptomatic diverticulosis.

## Methods

We screened PubMed from inception to 16 December 2020 in any language using the following search strategy: (((diverticulosis) OR (diverticulitis)) AND (surgery) AND ((pain) OR (patient satisfaction) OR (quality of life)) AND (colon)) (Appendix 1 Figure 2). The inclusion criteria were (1) a clinical study or case series with patients treated surgically due to diverticulosis or diverticulitis, (2) a follow-up after surgery of at least 3 months and (3) endpoints including one or more of the following: abdominal pain, functional abdominal problems, HRQoL and/or patient satisfaction after surgery. Exclusion criteria were (1) article in another language than English or German and (2) case reports or systematic reviews/meta-analyses (however with inclusion of individual studies).

Extracted parameters included study size, centrality, average age, gender proportion, duration of follow-up, numbers lost to follow-up, diagnostic procedures, and the specific indication for surgery among included patients. Furthermore, outcome parameters describing the outcome of the studies, that is, adverse and favourable outcomes and the respective assessment tools, were recorded.

HRQoL estimates daily quality of life according to a subjective evaluation by the patient regarding several aspects of his/her health (e.g. physical or mental limitations, energy level, mood) related to the underlying disease.<sup>8</sup> Several scores have been derived to quantify HRQoL in gastrointestinal diseases. The Gastrointestinal Quality of Life Index (GIQLI) is a widely used disease-specific

questionnaire for gastrointestinal, physical and psychological symptoms.<sup>9</sup> Other HRQoL scores include disease-specific questionnaires such as the Fecal Incontinence Quality of Life Scale (FIQoL),<sup>10</sup> the Cleveland Global Quality of Life (CGQL)<sup>11</sup> and Padova Inflammatory Bowel Disease Quality of Life (PIBDQL)<sup>12</sup> for inflammatory bowel disease, and rather general HRQoL scores, that is, the Medical Outcomes Survey Short Form 36 (SF-36),<sup>13</sup> EuroQoL 5-D score,<sup>14</sup> and the visual analogue scale (VAS) score for general quality of life.

This literature review summarizes evidence from currently available studies, which had been approved by their respective institutional review boards. Therefore, an additional institutional review for this project was not necessary.

## Results

Primary PubMed search identified 620 records (Appendix 1 Figure 1). Three additional publications were retrieved from the list of references of other publications. Out of 623 publications, 583 were excluded after screening of the abstract. From the remaining 40 studies, 17 were excluded after full-text assessment. The remaining 23 publications were included in the final literature review (Appendix 1 Figure 1, Table 1).

### HRQoL and patients' satisfaction

Out of 23 studies, 20 provided postoperative HRQoL measurements after diverticular resection (Table 2),<sup>15–30,32,34,36,37</sup> 10 thereof with an additional preoperative questionnaire.<sup>15–18,20,22,23,25,29,36</sup> and 2 with a conservatively treated control group.<sup>16,17</sup> Among them, HRQoL was recorded in 11 studies after elective surgery.<sup>15,16,20–23,25,27,29,32,36</sup>

In most of these studies, HRQoL increased after surgical treatment.<sup>15–18,22,23,25,29,36</sup>

Some studies deserve special mention. The randomized controlled study with the longest follow-up of 5 years included 108 surgically *versus* conservatively treated patients suffering from recurrent diverticulitis and/or ongoing symptoms related to diverticulosis.<sup>16</sup> Five years after randomization, GIQLI was significantly higher in the surgical than in the conservative group with a significant improvement from baseline in both groups. However, improved GIQLI scores in the

Table 1. General characteristics.

Publication	Study period (n)	Sample size (n)	Study design	Indication for surgery	Diagnosis based on	Surgical intervention	Patients' characteristics	Mean age (years)	Lost to follow-up	Time points of questionnaires for HRQoL and functional outcomes
Raue et al. <sup>15</sup>	2005–2008	156	Randomized controlled trial	Complicated sigmoid diverticular disease with pericolic inflammation ± abscess, recurrent disease with stenosis, fistula or bleeding	CT, colonoscopy or ultrasound	Elective LSR versus OSR	34% male, mean BMI 27	66	1.2% (n = 2)	At inclusion/ before surgery, at 7 days, 3 weeks, 3 months, 12 months
Bolkenstein et al. <sup>16</sup>	2010–2014	109	Randomized controlled trial	Ongoing abdominal complaints and/or recurrence after first episode of sigmoid diverticulitis	CT, colonoscopy or ultrasound	Elective sigmoid resection (preferably LSR) versus conservative management	Operative: 28% male, mean BMI 28.7; Conservative: 43% male, mean BMI 27.8	Operative: 54 Conservative: 56	8% (n = 9)	At inclusion/ before surgery, at 3, 6, 9, and 12 months and 5 years after inclusion
Polese et al. <sup>17</sup>	2009–2014	97	Retrospective cohort	Uncomplicated sigmoid diverticulitis	CT and/or colonoscopy	Urgent LSR or OSR versus conservative management	44.3% male	61	n.a.	At inclusion/ before surgery (in retrospect), follow-up questionnaire (time point not specified)
Turollo et al. <sup>18</sup>	2004–2013	47	Retrospective cohort	Diverticular disease	n.a.	Urgent and elective colonic resection (open + laparoscopic)	44.6% male	n.a.	4% (n = 2)	No baseline. Postoperative questionnaire after mean follow-up of 66 months
Magdeburg et al. <sup>19</sup>	2005–2013	362	Retrospective cohort	Colonic cancer or diverticular disease	n.a.	Urgent and elective colonic resection (open + laparoscopic)	56.2% male. Mean BMI: 26.6, ASA 1–4	70	18% (n = 65)	No baseline, postoperative questionnaire after mean follow-up of 50 months
Steinemann et al. <sup>20</sup>	2013–2015	25	Prospective cohort	Symptomatic left-sided diverticular disease or recurrent diverticulitis	CT and/or colonoscopy	Elective transrectal rigid hybrid natural orifice transluminal endoscopic sigmoidectomy	100% male. Mean BMI: 25.7, ASA 1–3	52.4	20% (n = 5)	Before surgery, at 3 and 6 months after surgery

(Continued)

Table 1. (Continued)

Publication	Study period	Sample (n)	Study design	Indication for surgery	Diagnosis based on	Surgical intervention	Patients' characteristics	Mean age (years)	Lost to follow-up	Time points of questionnaires for HRQoL and functional outcomes
Venara <i>et al.</i> <sup>21</sup>	2007–2013	16	Retrospective cohort	Sigmoid stricture associated with diverticular disease	CT and/or colonoscopy	Elective LSR or OSR	Median BMI: 23.6, ASA 1–3, Male/female: 43.8%	69.5 (median)	31% (n = 5)	No baseline, postoperative questionnaire between 1 and 8 years
Vestweber <i>et al.</i> <sup>22</sup>	2009–2013	329	Prospective cohort	Complicated or frequently recurring diverticulitis	CT and/or ultrasound	Elective single port laparoscopic surgery	42.2% male, Mean BMI: 26.3, ASA 1–3	57	33% (n = 111)	Before surgery, at 6 months after surgery
van de Wall <i>et al.</i> <sup>23</sup>	2005–2011	137	Retrospective cohort	Recurring or persisting complaints after an episode of diverticulitis	CT and/or ultrasound	Elective LSR or OSR	56.2% male, ASA 1–3	56.2	23% (n = 32)	Before surgery, at 1 year after surgery
Masoni <i>et al.</i> <sup>24</sup>	2004–2010	107	Randomized controlled trial	Symptomatic diverticular disease	n.a.	Elective or urgent laparoscopic left hemicolectomy with <i>versus</i> without preservation of inferior mesenteric artery	55.1% male, Mean BMI: 28.2, ASA 1–3	64 (median)	0% (n = 0)	No baseline, postoperative questionnaire at 6 months
Pasternak <i>et al.</i> <sup>25</sup>	1999–2006	130	Prospective cohort study	Diverticular disease of the left colon	Clinical or radiographic suspicion based on endoscopically proven sigmoid diverticulosis	Elective LSR	43% male, median BMI 26.6	59	7.7% (n = 10)	Before surgery (in retrospect), at 1 year after surgery (partly in retrospect), questionnaire for the last 3 months prior to data collection
Levack <i>et al.</i> <sup>26</sup>	2001–2008	325	Retrospective cohort study	Sigmoid diverticulitis	ICD-9 code 562.11	Elective or urgent LSR and/or OSR	51.5% male	57.4	n.a.	No baseline, postoperative questionnaire after a mean follow-up of 50.1 months

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Table 1. (Continued)

Publication	Study period (n)	Sample (n)	Study design	Indication for surgery	Diagnosis based on	Surgical intervention	Patients' characteristics	Mean age (years)	Lost to follow-up	Time points of questionnaires for HRQoL and functional outcomes
Gervaz <i>et al.</i> <sup>27</sup>	2005–2009	113	Randomized controlled trial	Sigmoid diverticulitis	n.a.	Elective LSR and/or OSR	43% male, Mean BMI: 26.5, ASA 1–3	61	7% (n = 8)	No baseline, postoperative questionnaire after a median follow-up of 30 months
Scarpa <i>et al.</i> <sup>28</sup>	1999–2008	71	Cross-sectional study	Colonic diverticular disease	Barium enema, colonoscopy, CT and/or ultrasound	Elective or urgent laparoscopic or open colonic resection, (additional groups for medical therapy and healthy volunteers)	Laparoscopic group: 27.3% male. Laparotomy: 41.7% male	65	n.a.	No baseline, postoperative questionnaire (time point not specified)
Forgione <i>et al.</i> <sup>29</sup>	n.a.	48	Prospective cohort study	Sigmoid diverticulitis	Abdominal and pelvic CT at the time of attack	Elective LSR	56% male, Mean BMI: 27, ASA 1–3	58.3	4% (n = 2)	Preoperative and postoperative questionnaires at 3, 6 and 12 months.
Scarpa <i>et al.</i> <sup>30</sup>	1998–2005	149	Cross-sectional study	Colonic diverticular disease	Barium enema, colonoscopy, CT, X-ray and/or ultrasound	Laparoscopic versus open colonic resection versus medical therapy	32% male	67	52% (n = 78)	No baseline, questionnaire after a median follow-up of 47 months
Egger <i>et al.</i> <sup>31</sup>	1999–2004	162	Prospective cohort study	Sigmoid diverticulitis	CT, clinical symptoms, need for antibiotics	Elective LSR/OSR versus urgent LSR/OSR	64% male	61.2	23% (n = 38)	No baseline, questionnaire after a mean follow-up of 33 months
Seitz <i>et al.</i> <sup>32</sup>	1996–2002	77	Case-control study	Recurrent diverticulitis or colonic neoplasia	n.a.	Elective LSR versus OSR	45% male, Mean BMI: 26.6	60.5	n.a.	No baseline, questionnaire after a mean follow-up of 40.5 months
Ambrosetti <i>et al.</i> <sup>33</sup>	1998–2005	43	Prospective cohort study	Acute diverticulitis of the left colon	CT	Elective LSR	48.8% male	59.5	4% (n = 2)	No baseline, questionnaire after a mean follow-up of 40 months

(Continued)

Table 1. (Continued)

Publication	Study period (n)	Study design	Indication for surgery	Diagnosis based on	Surgical intervention	Patients' characteristics	Mean age (years)	Lost to follow-up	Time points of questionnaires for HRQoL and functional outcomes
Constantinides <i>et al.</i> <sup>34</sup>	1981–2003	Cross-sectional study	Complicated diverticular disease	n.a.	Elective or urgent PRA versus HP	PRA group: 55.1% male HP group: 63.3% male	PRA group: 63.3 HR group: 67.3	n.a.	No baseline, questionnaires for three separate groups: (1) <3 years, (2) 3–6 years, (3) >6 years after surgery
Munson <i>et al.</i> <sup>35</sup>	1991–1994	Cross-sectional study	Diverticulitis	Sigmoidoscopy, CT, barium enema or laparoscopy	Surgical and medical treatment	51% male	55	n.a.	No baseline, follow-up questionnaire (time point not specified)
Klarenbeek <i>et al.</i> <sup>36</sup>	2002–2006	Randomized controlled trial	Diverticulitis of sigmoid colon	n.a.	Elective LSR or OSR	LSR group: 43% male, mean BMI 27.3, OSR: 24% male, mean BMI: 28.5, ASA 1–3	n.a.	27% (n = 28)	Before surgery, at 6 weeks, and 6 months after surgery
Thörn <i>et al.</i> <sup>37</sup>	1989–1994	Retrospective cohort study	Diverticulitis, colonic stenosis, abscess or fistula, functional problems	Radiography with barium enema or colonoscopy	Elective colonic resection.	32% male	56	15% (n = 11)	No baseline, questionnaire after a mean follow-up of 4 years

ASA, American Society of Anesthesiologists Physical Status Classification; BMI, body mass index (kg/m<sup>2</sup>); HP, Hartmann's procedure; HRQoL, health-related quality of life; ICD-9, International Classification of Diseases, Ninth Revision; LSR, laparoscopic sigmoid resection; n.a., not available/applicable; OSR, open sigmoid resection; PRA, primary colonic resection and anastomosis.

**Table 2.** Outcome data.

Author/year of publication	Study design	Outcome assessment tools	HRQoL	Functional outcomes	Adverse postoperative outcomes (most frequent)	Postoperative abdominal pain	Patients' satisfaction
Raue <i>et al.</i> <sup>15</sup>	Randomized controlled trial	VAS, Global health status scale (EORTC-QLQ-C30 v3)	↑ HRQoL improved after both LSR and OSR; however, no dedicated analysis on the statistical significance conducted. No difference in HRQoL between LSR and OSR.	Delayed bowel mobility: 3.4%	Anastomotic leakage, intra-abdominal/pelvic abscess, postoperative bleeding, other reasons for reoperation: 10% Death: 1% Wound infection: 21%. Higher incidence of wound infection after conversion from LSR to OSR	No difference in pain levels between LSR and OSR. No analysis on change in VAS pain level from baseline.	n.a.
Bolkenstein <i>et al.</i> <sup>16</sup>	Randomized controlled trial	GIQLI, EQ5D, SF-36, VAS-pain	↑ GIQLI score significantly higher among operated patients [mean 118.2 (SD = 21.0)] than among conservative group [108.5 (SD = 20.0)] with a mean difference of 9.7 (95% confidence interval 1.7–17.7). All secondary HRQoL measures significantly better in the operative group, with a higher SF-36 physical ( $p = 0.030$ ) and mental score ( $p = 0.010$ ), and higher EQ5D score ( $p = 0.016$ ).	n.a.	Anastomotic leakage: 11% Reinterventions: 15% Persistent stoma after 5 years: 2% Recurrent diverticulitis: 11%	Lower VAS pain score in operated patients ( $p = 0.01$ ). VAS-pain [0–100, operated <i>versus</i> conservative]: 28.6 <i>versus</i> 44.1 at 5 years after surgery	n.a.
Polese <i>et al.</i> <sup>17</sup>	Retrospective cohort	DV-QoL, SF-36	↑ Improved postoperative HRQoL, differences between pre- and post-treatment HRQoL higher in surgical than conservative group [21.2 to 6.9 <i>versus</i> 15.41 to 10.61, $p < 0.01$ ]. Higher vitality in operated patients <i>versus</i> those with conservative treatment according to SF-36	Constipation: 8.2%	Surgical site infection: 9.3% Anastomotic leakage: 1% Anastomotic stenosis: 6.2% Postincisional hernia: 4.1% Haemorrhage: 4.1%	No difference in change of bodily pain from baseline in the surgical <i>versus</i> conservative group	n.a.
Turoldo <i>et al.</i> <sup>18</sup>	Retrospective cohort	MBFI, SF-36, FISl	↑ 87.2% defined HRQoL correlated to bowel function as good or very good. HRQoL improved in 71% after surgery.	Faecal urgency: 4.25% Incomplete evacuation: 17.03% Poor bowel function 4.3% Constipation: 36.2% Diarrhoea: 4% No cases of incontinence.	n.a.	Significant reduction in abdominal pain after surgery	91.4% of patients satisfied with the choice of surgery and would agree to do it again.

(Continued)

Table 2. (Continued)

Author/year of publication	Study design	Outcome assessment tools	HRQoL	Functional outcomes	Adverse postoperative outcomes (most frequent)	Postoperative abdominal pain	Patients' satisfaction
Magdeburg <i>et al.</i> <sup>19</sup>	Retrospective cohort	FIQL, SF-12, additional questions	↓ Postoperative HRQoL: 4.4% excellent, 18.9% very good, 57.2% good, 16.8% fair, 2.7% poor. Limited HRQoL due to bowel symptoms: 25%	Faecal urgency > 1/week: 3.4%, > 1/month: 12.5% Incontinence > 1/week: 5.4%, > 1/month: 11.5% Liquid stool > 1/week: 14.1%, > 1/month: 26.6% Stool soiling > 1/week 0.7%, > 1/month 11.1%	Major complications (Clavien-Dindo classification 3-4): 9.4%. Re-operation: 7.7%	n.a.	n.a.
Steinemann <i>et al.</i> <sup>20</sup>	Prospective cohort	GIQLI, SHIM, body image scale, St. Marks incontinence score	↔ GIQLI pre- versus postoperative: 124 versus 128.8 points ( <i>p</i> = 0.54)	No change in stool consistency, nocturnal defaecation, and evacuation difficulties, as well as in mean St Marks incontinence score 3 and 6 months compared after surgery	Postoperative complications: 16% Re-operation: 4%	n.a.	n.a.
Venara <i>et al.</i> <sup>21</sup>	Retrospective cohort	GIQLI	? Mean postoperative GIQLI: 122.	n.a.	Complications: 31.2% Minor (Clavien-Dindo): 25% Anastomotic leakage: 6.2%, none resulted in death.	n.a.	90% of patients satisfied and willing to undergo surgery again.
Vestweber <i>et al.</i> <sup>22</sup>	Prospective cohort	GIQLI, VAS	↑ Significant improvement of HRQoL: mean GIQLI score pre- versus postoperative: 102 versus 110.8	n.a.	Anastomotic leakage: 4% Haemorrhage: 3% Wound infection: 5.8% Incisional hernia: 4.9% Recurrent diverticulitis: 0.3% Mortality: 0.3%	Median VAS-pain scores were 4 (0.5-9), 3 (0-10) and 2 (0-8) on postoperative days 1, 3 and 5, respectively.	n.a.
van de Wall <i>et al.</i> <sup>23</sup>	Retrospective cohort	VAS for HRQoL, abdominal pain, abnormal defaecation, fatigue	↑ Median VAS for HRQoL (0-100) pre-/postoperative: 40 versus 80. Surgery beneficial to HRQoL among 89.3%.	Improved abnormal defaecation: 77.1%. Most patients remain mildly symptomatic after resection.	Incisional hernia: 5.7% Anastomotic leakage: 4.8% Severe bleeding: 1% Re-operation: 5.8% Wound infection: 8.9% Anastomotic abscess: 1.9%	Improved abdominal pain in 87.5%. VAS score decrease from 80 to 20.	n.a.

(Continued)



Table 2. (Continued)

Author/year of publication	Study design	Outcome assessment tools	HRQoL	Functional outcomes	Adverse postoperative outcomes (most frequent)	Postoperative abdominal pain	Patients' satisfaction
Masoni <i>et al.</i> <sup>24</sup>	Randomized controlled trial	Anorectal manometry, SF-36	? SF-36 questionnaire: statistically greater physical function ( $p = 0.046$ ), physical role ( $p = 0.021$ ), general health ( $p = 0.013$ ), social functioning ( $p = 0.028$ ), and emotional role ( $p = 0.010$ ) in preserved IMA group	Minor incontinence: 10% Constipation: 32.7% Fragmated evacuation: 36.4% Alternating bowel function: 32.7% Defaecation disorders: 52.3%	n.a.	n.a.	n.a.
Pasternak <i>et al.</i> <sup>25</sup>	Prospective cohort study	GIQLI	↑GIQLI > 100 in 48% before surgery. GIQLI > 100 in 83% after surgery. Mean GIQLI before versus after surgery: 95 versus 114 ( $p < 0.01$ ). Lower GIQLI in women than men pre- and postoperatively (GIQLI 88110 versus 107120, $p < 0.01$ )	n.a.	Anastomotic leak: 2.3%, Intra-abdominal abscess: 0.8%, superficial wound infection: 1.5%, prolonged paralytic ileus: 1.5%, anastomotic stenosis: 6.9%, incisional hernia: 2.3%, recurrent diverticulitis: 9%	n.a.	96% of the patients were satisfied with the surgery.
Levack <i>et al.</i> <sup>26</sup>	Retrospective cohort study	FISI, FIQoL, MBFI	↓Patients with faecal incontinence with a relevant decrease in HRQoL (figures for FIQoL not provided)	Faecal incontinence: 24.8% Faecal urgency: 19.6% (more in female) Incomplete emptying: 20.8% (more in female)	Anastomotic leak: 2.4% Sepsis: 1.2% Intra-abdominal abscess: 3%	n.a.	n.a.
Gervaz <i>et al.</i> <sup>27</sup>	Randomized controlled trial	GIQLI	? Median postoperative GIQLI score OSR versus LSR: 115 versus 110 points ( $p = 0.17$ )	n.a.	Recurrent diverticulitis: 1.9% Small bowel obstruction: 1% Incisional hernia: 11.4%	n.a.	Overall satisfaction with operation: 9/10 points
Scarpa <i>et al.</i> <sup>28</sup>	Cross-sectional study	PIBDQL, CGQL, VAS, BIQ, DDSS, BSFS	↓PIBDQL significantly worse in operated patients versus healthy subjects. Current HRQoL were worse in operated patients	No significant difference in DDSS between conservatively treated and operated patients	Complications (not specified): 19.6%	n.a.	n.a.
Forgione <i>et al.</i> <sup>29</sup>	Prospective cohort study	GIQLI	↑Mean preoperative GIQLI score: 99.5, at 3 months: 113.5, at 6 months 112.8, at 12 months 111.5 postoperatively (each with $p < 0.05$ )	No difference in weekly stool frequency at any time point compared to preoperative situation.	n.a.	n.a.	n.a.

(Continued)

Table 2. (Continued)

Author/year of publication	Study design	Outcome assessment tools	HRQoL	Functional outcomes	Adverse postoperative outcomes (most frequent)	Postoperative abdominal pain	Patients' satisfaction
Scarpa <i>et al.</i> <sup>30</sup>	Cross-sectional study	CGQL	? Total CGQL scores and symptom frequency rate similar in surgically and medically treated patients. Only current QoH significantly worse in operated patients ( $p = 0.05$ ).	Fever: 17% Constipation: 43% Diarrhoea: 17% Bloating: 30%	Complications (not specified): 16%	Abdominal pain: 43%	n.a.
Egger <i>et al.</i> <sup>31</sup>	Retrospective cohort study	Postoperative questionnaire resumption of work, recurrent diverticulitis, incisional hernia, scare pain	n.a.	Persistent symptoms after surgery: 25%, thereof: Painful constipation: 36.7%, Painful abdominal distension: 23.3% Abdominal cramps: 23.3%, Frequent painful diarrhoea: 23.3%	Incisional hernia: LSR versus OSR: 3% versus 19%, $p < 0.05$	See functional outcomes	Well-being regarding surgical intervention and follow-up: very good: 51%, good: 42%, moderate: 6% poor: 1%.
Seitz <i>et al.</i> <sup>32</sup>	Case-control study	GIQLI	? Among patients undergoing sigmoid resection for recurrent diverticulitis, mean GIQLI at follow up was 95/144 points.	Diarrhoea: 16.8% Constipation: 10.4% Flatulence: 14.3%	Significantly more complications in open surgery versus laparoscopic approach ( $p < 0.01$ ). Overall: 27.3%, urinary tract infection: 10.4%, hematoma: 3.9%, pneumonia: 3.9%, wound infection: 1.3%, anastomotic stenosis: 1.3%, ileus: 1.3%	Postoperative pain: 18.2%.	Satisfaction about cosmetic result: 97% in LSR versus 63% in OSR group ( $p < 0.01$ )
Ambrosetti <i>et al.</i> <sup>33</sup>	Prospective cohort study	Postoperative questionnaire	n.a.	Improved bowel movement: 56% Unchanged bowel function: 37% Worse bowel function: 7%	n.a.	New abdominal pain: 9.3%	Final results classified as: Excellent: 47% Good: 40% Mediocre: 13%. 95% would repeat surgery.
Constantinides <i>et al.</i> <sup>34</sup>	Cross-sectional study	SF-36	? Compared to the US SF-36 norm, patients from both groups (PRA and HP) scored lower in the social function and general health domains. The mean SF-36 score of all eight domains was 539.8 in the PRA group and 540.8 in the HP group.	In the PRA group 19.6% reported to wear pads during the day and 8.7% during night. In the HP group 10% during the day and 6.7% during night	Any complication after 30 days: 25.5% Prolonged ileus: 8.8% Postoperative hernia: 6.4% Re-operation rate: 10.6% Wound infection: 5.3%	n.a.	n.a.

(Continued)

Table 2. (Continued)

Author/year of publication	Study design	Outcome assessment tools	HRQoL	Functional outcomes	Adverse postoperative outcomes (most frequent)	Postoperative abdominal pain	Patients' satisfaction
Munson <i>et al.</i> <sup>35</sup>	Cross-sectional study	Telephone interview	n.a.	Ongoing symptoms in 27.2% of surgically treated patients.	n.a.	Pain quality unchanged in 2/3, completely different pain in 1/3	n.a.
Klarenbeek <i>et al.</i> <sup>36</sup>	Randomized controlled trial	SF-36	↑ HRQoL after six weeks: significantly improved role limitations due to physical health as well as role limitations due to emotional problems, social functioning, and pain in LSR <i>versus</i> OSR patients. Differences no longer significant after 6 month follow-up. No dedicated analysis on difference between SF-36 at baseline and follow-up for entire study population.	n.a.	Complications: 30.8% Incisional hernia: 2.9% Small bowel obstruction: 4.8% Re-operation rate: 8.7% Recurrent diverticulitis: 1% Enterocutaneous fistula: 3.8% Anastomotic leakage: 3.8% Intra-abdominal abscess: 1% Fewer complications after LSR than OSR (17.3% LSR <i>versus</i> 44.2% OSR; $p < 0.01$ )	See HRQoL	n.a.
Thörn <i>et al.</i> <sup>37</sup>	Retrospective cohort study	Questionnaire	n.a.	62% reported changes in bowel function after the operation. No further details on functional outcomes during follow-up	Complications: 33% Re-operation rate: 13% Incisional hernia: 12% Anastomotic leakage: 5% Postoperative bleeding: 3% Douglas abscess: 3% Bowel obstruction: 3% Recurrent diverticulitis: 8% Wound infection: 5%	n.a.	Excellent or good overall results regarding bowel function: 78%

BIQ, Body Image Questionnaires; BSFS, Bristol Stool Form Scale; CGQL, Cleveland Global Quality of Life; DDSS, diverticular disease symptom score; DV-QoL, Diverticulitis quality of life questionnaire; EORTC-QLQ-C30 v3, European Organisation for Research and Treatment of Cancer Quality-of-Life Questionnaire Core 30, 3rd version; EQ5D, EuroQoL 5-D score; FiQoL, Faecal Incontinence QoL Scale; FISI, Faecal Incontinence Severity Index; GIQLI, Gastro-intestinal quality of life Index; HP, Hartmann's procedure; HRQoL, health-related quality of life; IMA, inferior mesenteric artery; LSR, laparoscopic sigmoid resection; MBFI, Memorial Bowel Function Index; n.a., not applicable/available; OSR, open sigmoid resection; PIBDQL, Padova Inflammatory Bowel Disease Quality of Life; PRA, primary colonic resection and anastomosis; SD, standard deviation; SF-36, Medical Outcomes Survey Short Form 36; VAS, visual analogue scale; ↑, overall improvement in HRQoL after diverticular surgery; ↔, no change in HRQoL after diverticular surgery; ↓, deterioration in HRQoL after diverticular surgery; ?, insufficient information for longitudinal assessment of HRQoL after diverticular surgery.

conservative group might be overestimated owing to a relevant cross-over rate to surgery of 46%.

Consistently, data from an Italian retrospective cohort among 97 patients with uncomplicated sigmoid diverticulitis indicate a significantly increased HRQoL after surgical treatment (time points not specified) compared to their conservatively treated peers.<sup>17</sup>

HRQoL also increased in two randomized controlled trials upon laparoscopic or open sigmoid resection (the level of statistical significance was not assessed in one study<sup>15</sup>). In one study, no differences between laparoscopic and open resection were noted,<sup>15</sup> in the other, differences were no longer significant after 6 months.<sup>36</sup>

However, a relevant fraction with low overall HRQoL after diverticular surgery was noted in two retrospective,<sup>19,26</sup> one prospective<sup>20</sup> and one cross-sectional study,<sup>28</sup> but most of these studies did not have a reference HRQoL at baseline.

#### *Postoperative functional disorders*

Fifteen studies reported persistent or new postoperative functional symptoms in the absence of any physical correlate such as inflammation or stenosis<sup>15,17,18,24,26,28</sup> (Table 2). Thereof, seven studies provided longitudinal analyses with pre- and postoperative symptoms.<sup>20,23,28,29,31,33,35</sup> Furthermore, functional disorders after elective diverticular surgery were recorded in seven studies.<sup>15,20,23,29,32,33,37</sup>

The most frequently reported functional complaints were defaecation disorders in six studies such as abnormal defaecation, faecal incontinence, difficult or incomplete evacuation, or nocturnal defaecation.<sup>18–20,23,24,26</sup> Thereof, two studies provided longitudinal comparisons with a positive impact of both elective laparoscopic and open sigmoid resection on abnormal defaecation in 77.1% in the retrospective cohort study by van de Wall *et al.*,<sup>23</sup> while the prospective cohort study by Steinemann *et al.*<sup>20</sup> assessing the impact of elective transrectal rigid hybrid natural orifice transluminal endoscopic sigmoidectomy showed no significant improvement in nocturnal defaecation, difficult or incomplete evacuation. The four remaining studies only provided cross-sectional data; new or persistent defaecation disorders were reported among a fourth<sup>18</sup> to a half<sup>24</sup> of the study populations.

The most severe post-surgical defaecation disorder is faecal incontinence. Different measures for incontinence were applied and incontinence rates ranged from 5.4% involuntary stool loss once a week to 11.4% once a month,<sup>19</sup> 10%,<sup>24</sup> or 24.8%<sup>26</sup> in other studies. Only in the prospective cohort study by Steinemann *et al.*,<sup>20</sup> St. Marks incontinence score was repeatedly assessed preoperatively and at 6 and 12 months and no significant dynamics upon surgery was observed. Furthermore, faecal urgency was a common postoperative finding among 4.25% of patients in the retrospective cohort study by Turollo *et al.*,<sup>18</sup> while Magdeburg *et al.*<sup>19</sup> reported urgency in 3.4% of patients more than once a week and in 12.5% more than once a month. Fragmented or incomplete evacuation was reported in three studies ranging in frequency between 17%,<sup>18</sup> 20.8%<sup>26</sup> and 36.4%.<sup>24</sup>

Diarrhoea and constipation are equally common after diverticular surgery with rates of diarrhoea ranging from 4%<sup>18</sup> to 23.3%<sup>31</sup> and constipation from 10.4%<sup>32</sup> to 43%<sup>30</sup> of the study populations, respectively. Alternating diarrhoea and constipation was found in 32.7%.<sup>24</sup> Bloating and flatulence were also a common symptom in 14.3%<sup>32</sup> to 30%<sup>30</sup> of patients.

Seven longitudinal studies on functional outcomes after diverticular surgery are available.<sup>20,23,28,29,31,33,35</sup> Of these studies, three prospective<sup>20,29,33</sup> and one retrospective cohort study<sup>23</sup> focus on elective diverticular surgery.<sup>20,23,29,33</sup> Overall, these longitudinal studies showed an improved or at least unchanged rate of functional disorders. Improvements in defaecation symptoms were found in 77.1% in a retrospective cohort of patients undergoing elective laparoscopic or open sigmoid resection due to ongoing complaints after a first episode of conservatively treated diverticulitis.<sup>23</sup> In a prospective cohort study after elective laparoscopic sigmoid resection (LSR) by Ambrosetti *et al.*,<sup>33</sup> satisfaction with bowel movements improved in 56%, remained unchanged in 37% and worsened in 7%.

However, functional outcomes did not change in two studies. In the prospective cohort study by Steinemann *et al.*<sup>20</sup> which used an innovative surgical-endoscopic hybrid approach, no postoperative change in stool consistency, nocturnal defaecation, stool evacuation and incontinence was reported, as compared to preoperative symptoms. Similarly, in another prospective cohort

study observing patients after LSR due to sigmoid diverticulitis, no difference in stool frequency was noted.<sup>29</sup>

Despite a relevant proportion of functional disorders after surgery, most studies reported a good postoperative HRQoL<sup>15–18,22,23,25,29,36</sup> and patients' satisfaction<sup>18,21,25,31,33,37</sup> even in the presence of these gastrointestinal symptoms.

#### *Postoperative abdominal pain*

Eleven studies assessed postoperative pain during follow-up.<sup>15–18,22,23,30–33,35,36</sup> Four studies assessed the dynamics of abdominal pain pre- and postoperatively.<sup>17,18,23,33</sup> Eight studies reported on postoperative pain only after elective diverticular surgery.<sup>15,16,22,23,27,32,33,36</sup>

Decreased abdominal pain after surgery was reported in a randomized controlled trial<sup>16</sup> and two longitudinal studies.<sup>18,23</sup> Bolkenstein *et al.*<sup>16</sup> found a significant decrease in VAS pain levels from baseline in both surgically and conservatively treated patients with ongoing complaints after a first episode or recurrent diverticulitis; however, reduction in pain levels was significantly greater in operated patients compared to their conservatively treated counterparts even 5 years after baseline ( $p = 0.01$ ). In the retrospective cohort study by van de Wall including 137 patients after elective laparoscopic and open sigmoid resection for diverticular disease, 87.5% experienced decreased abdominal pain after operation.<sup>23</sup> Consistently, the retrospective cohort study by Turollo *et al.*<sup>18</sup> reported a significant reduction in abdominal pain among 47 patients after both urgent and elective colonic resection ( $p = 0.02$ ).

However, the retrospective cohort study by Polese *et al.*<sup>17</sup> did not find a significant change in pain levels before and after urgent laparoscopic or open sigmoid resection. Other studies reported persistent abdominal pain in 18%<sup>32</sup> and 43%,<sup>30</sup> respectively, or persistent (mostly painful) symptoms in overall 25%.<sup>31</sup> New abdominal pain after surgery was reported in 9.3% in the prospective cohort study by Ambrosetti *et al.*<sup>33</sup>

#### *Patient satisfaction*

Patient satisfaction was addressed in six studies. The majority of patients (78–96%) considered

surgical results and the functional outcome after surgery to be very good or good;<sup>18,21,25,27,31,33,37</sup> 90–95% of patients would be willing to undergo the surgery again.<sup>18,21,33</sup> In one study, assessment of satisfaction was limited to the cosmetic results which were higher after laparoscopic surgery (97%) than after open surgery (63%).<sup>32</sup>

#### **Discussion**

Overall, this review summarized evidence from 23 original publications regarding postoperative HRQoL, functional gastrointestinal disorders, and abdominal pain.

Most studies agreed upon a good or even increased HRQoL<sup>15–18,22,23,25,29,36</sup> and high patients' satisfaction regarding the operation.<sup>18,21,25,31,33,37</sup> However, literature on functional outcomes and postoperative pain after diverticular surgery is still not sufficient to draw a clear conclusion, especially due to the scarcity of longitudinal assessments and preoperative objective measurements. Nevertheless, a relevant number of studies indicate the possibility of new or persistent abdominal pain,<sup>15–18,22,23,30–33,35,36</sup> and a few studies reported unchanged or decreased HRQoL<sup>19,20,26,30</sup> even after successful and uncomplicated abdominal surgery. Although functional disorders were commonly reported in almost every fourth postoperative patient in cross-sectional analyses,<sup>15,17,18,24,26,28–37</sup> there was no evidence for a functional deterioration before and after elective diverticular surgery in longitudinal studies.

These results have to be interpreted cautiously in the light of highly heterogeneous study designs, quality, patients' selection, operation techniques and length of follow-up. For instance, the outcome measurement tools were not standardized and validated in a relevant subset of studies.<sup>31,33,35,37</sup> Therefore, direct comparisons are not meaningful, and a meta-analysis would be potentially misleading.

Various explanations regarding the inconsistent results of the impact of diverticular surgery on HRQoL are conceivable. Obviously, HRQoL, postoperative functional disorders and abdominal pain are very subjective parameters, which may be influenced by a recall bias when recorded retrospectively and may vary according to the setting of urgent and elective interventions as well as the

surgical approach for diverticular disease. Furthermore, postoperative complications and related surgical re-interventions may provoke persistent functional disorders and abdominal pain and therefore reduced HRQoL. The current review summarizes the most frequent postoperative complications (Table 2); however, no study stratified for operated patients with and without complications after diverticular surgery in regard to postoperative HRQoL, functional disorders, and abdominal pain, which emphasizes the need for future research in this field.

Several systematic literature reviews and international guidelines<sup>6,7</sup> concluded that elective diverticular surgery should not be routinely performed in every patient after the second episode of diverticulitis. There is a broad consensus on a lower risk for recurrent diverticulitis or other complications of diverticulosis after surgery with a diverticulitis recurrence rate of 4.2% after elective LSR for diverticulitis.<sup>38</sup> However, surgery should be indicated after a careful and thorough individualized patient selection since previous episodes of uncomplicated diverticulitis were not found to predict recurrence, severity of future attacks, and need for emergency operations.<sup>39</sup>

Another factor is the presence of irritable bowel syndrome (IBS) in patients undergoing diverticular surgery which could be one of the reasons for reduced postoperative HRQoL, persistent or increasing functional symptoms, and abdominal pain. This is relevant since the prevalence of IBS is estimated to be as high as 17% among patients with diverticular disease.<sup>40</sup> Therefore, screening, early recognition and adequate treatment of preoperative IBS are warranted before the evaluation of elective diverticular surgery.

Conversely, Cohen *et al.*<sup>41</sup> stated that patients with diverticulitis could be at risk for subsequent development of *de novo* IBS and other functional disorders and proposed the term post-diverticulitis IBS for this disorder. Furthermore, Jung *et al.*<sup>42</sup> reported a significantly increased likelihood for colonic diverticulosis in patients with IBS. These associations of IBS and colonic diverticular disease might be due to a shared etiopathogenesis of both conditions. Therefore, similar to post-infectious IBS, an attack of diverticulitis could trigger functional bowel disorders and post-diverticulitis IBS might be a variant of post-inflammatory IBS. Post-diverticulitis IBS might be responsible for

functional disorders after surgery for diverticular disease in some cases.

Especially for elective diverticular surgery, predictors for a favourable postoperative outcome regarding HRQoL, functional disorders and abdominal pain guiding this decision process are needed. Predictors for favourable postoperative outcomes and high patients' satisfaction were male sex,<sup>26</sup> absence of preoperative IBS,<sup>33</sup> length of the resected colon,<sup>33</sup> elective setting of the operation, multiple previous episodes of diverticulitis and low preoperative HRQoL.<sup>25,29</sup> Preoperative screening could be expanded using the validated irritable bowel severity scoring system by Francis *et al.*<sup>43</sup> to identify the presence of IBS before surgery. Furthermore, factors predisposing for IBS such as the gastrointestinal symptom-related anxiety and depression, a high Visceral Sensitivity Index,<sup>44</sup> and high scores in the Hospital Anxiety and Depression Scale<sup>45</sup> could be identified preoperatively. These factors might also be relevant as predictors for functional problems after diverticular surgery. However, such a strategy would need confirmation in larger prospective observational studies or dedicated randomized clinical trials.

Irrespective of positive results in most studies, a minority of patients remained with low/reduced HRQoL, persistent symptoms, new symptoms, abdominal pain and/ or low satisfaction with therapy. These unfavourable results can be a significant burden for patients and physicians. Strategies to reduce the rates of unfavourable outcomes including patient selection would be desirable and efficient strategies to support affected patients are needed. The least physicians can do now is to communicate the possibility of unfavourable outcomes clearly and transparently to patients before surgery.

Strength of the current review includes the large number of affected studies with overall 2948 patients. Limitations include the heterogeneous study design of most identified studies, precluding a quantitative summary or a meta-analysis. Furthermore, most studies have an observational (noninterventional) study design and large randomized controlled trials with preoperative assessment of risk factors, and long-term outcomes regarding abdominal function, pain and HRQoL assessed by validated and standardized tools would be desirable.

## Conclusion

The decision for elective diverticular surgery is complex. In recent years, surgical guidelines evolved from a strict recommendation for surgery after the second attack of diverticulitis to a more individualized approach. Current literature points to an improved HRQoL in most patients upon short- and long-term follow-up for up to 5 years. However, data on functional outcomes are controversial; while cross-sectional analyses found functional disorders after diverticular surgery in a relevant proportion of patients, functional disorders did not deteriorate in four longitudinal studies after elective diverticular surgery. Thus, careful preoperative clinical assessment regarding functional impairments including IBS and incontinence scoring should be considered. Finally, the indication for elective diverticular surgery should be discussed carefully with the patient, especially when preoperative IBS and predictors thereof are present.

## Author contributions

**Daniel Segna:** Conceptualization; Formal analysis; Investigation; Methodology; Project administration; Visualization; Writing – original draft; Writing – review & editing.

**Paul J. Jaklin:** Conceptualization; Data curation; Writing – original draft.

**Beat Schnüriger:** Supervision; Writing – original draft.

**Benjamin Misselwitz:** Conceptualization; Data curation; Formal analysis; Investigation; Project administration; Resources; Supervision; Visualization; Writing – original draft; Writing – review & editing.

## Conflict of interest statement

The authors declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: Prof. Misselwitz reports grants from MSD; personal fees from MSD, Vifor and Takeda, outside the submitted work. Dr Segna reports travelling fees from AbbVie, Vifor and Gilead and a research grant from the Novartis Foundation for Medical-Biological Research unrelated to this project. The other authors have nothing to disclose.

## Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

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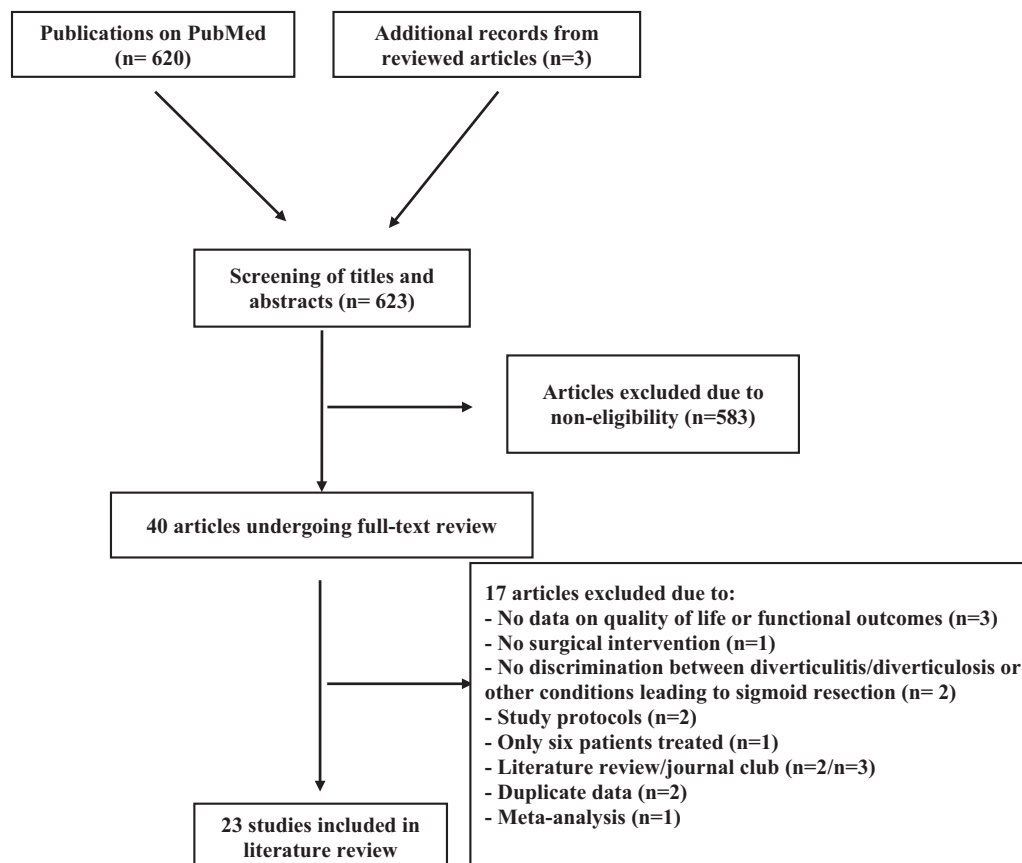
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## Appendix 1



**Figure 1.** Flow chart (inception–16 December 2020).

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RESULTS BY YEAR

1974 2021

Filters applied: Abstract, Full text. Clear all

1 [A man with chronic abdominal **pain** and obstipation].  
van Overbeeke AJ, Algie GD.  
Cite Ned Tijdschr Geneeskd. 2010;154:A1425.  
PMID: 20977800 Dutch.  
Share A 66-year old man presents with chronic **pain** in the abdomen and obstipation. Explorative laparotomy revealed that his symptoms were caused by a giant diverticle from the **colon** sigmoideum....

2 **Diverticulosis and Diverticulitis**.  
Feuerstein JD, Falchuk KR.  
Cite Mayo Clin Proc. 2016 Aug;91(8):1094-104. doi: 10.1016/j.mayocp.2016.03.012. Epub 2016 May 5.  
PMID: 27156370 Review.  
Share For this review article, we performed a review of articles in PubMed through February 1, 2016, by using the following MeSH terms: **colon** diverticula, **colonic diverticulitis**, **colonic diverticulosis**, **colonic diverticulum**, **colonic**...

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Full text

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Figure 2. Search strategy in PubMed.

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