



Routine Endoscopy Prior to Surgical Ostomy Closure: An Obsolete Concept

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Abstract

Background Closure of temporary diverting ostomies is commonly preceded by an endoscopic study of the colonic mucosa and anastomosis, despite lacking evidence of its relevance and impact on subsequent operative management.

Aim We sought to determine the incidence of pathological findings and therefore evaluate the clinical benefit of routine pre-operative endoscopy in asymptomatic patients, hypothesizing sole evaluation of the anastomotic integrity to be sufficient in these cases.

Methods We retrospectively identified all adult patients with ostomy installations who were followed up for potential reversal surgery between 2002 and 2020 at the University Hospital of Zurich, Switzerland. Main outcome measures were the incidence of endoscopically identified pathological findings in the asymptomatic case cohort and their impact on the subsequent course of treatment.

Results Pre-procedural endoscopic data of 187 cases evaluated for ostomy closure were evaluated. Relevant mucosal findings in the asymptomatic cohort were documented in 26.3% and findings at the anastomotic site detected in 8.7%. A change in subsequent surgical management was noted in 10 patients of the entire cohort (5.3%) and in 9 (5.1%) of all asymptomatic cases. Upon multivariate analyses, the age range of 51 to 60 years old was found to be significantly linked to the presence of endoscopic findings entailing a change in patient management.

Conclusion Our findings strongly suggest ostomy closure surgery without previous assessment of the bowel mucosa by means of endoscopy to be acceptable in asymptomatic patients. However, we found it to be indicated in all patients meeting the screening criteria for colorectal carcinoma.

Keywords Endoscopy · Colorectal surgery · Ostomy · Stoma · Stoma reversal · Anastomosis

Introduction

Temporary diverting ostomies are commonly performed in patients requiring colonic or small bowel segmental resection as well as emergency decompression in mechanical intestinal obstructions who are at risk for complications from

primary anastomosis. Ostomies are classified based on their location (small bowel vs. colonic ostomies), configuration (loop, double barrel, end) and timely intention (temporary vs. permanent) [1, 2].

Reversal, i.e., take-down and re-anastomosis, as a second-stage operation is commonly preceded by an evaluation of both the anastomotic region as well as the mucosal integrity of the complete remnant colon, the idea being that anastomotic leaks, stenosis, inflammation, and other mucosal lesions (i.e., polyps or cancerous tissue) may preclude or delay ostomy closure [3, 4].

As colonoscopy and flexible sigmoidoscopy are considered the gold standard for this purpose, the quality of bowel preparation poses a crucial determinant of procedural success [5], which in turn is rendered difficult to achieve in the presence of an ostomy. In addition, in up to 90% of patients diversion colitis arises in the bypassed bowel segments after

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ostomy formation, most of which remaining asymptomatic [6, 7], and receding in all patients after ostomy reversal [6, 8]. Diversion colitis, generally described as a non-specific mucosal inflammation, is reportedly associated with endoscopic findings, such as diffuse granularity, erythema, mucous plugs, reduction of the vascular pattern, erosions, aphthous-type lesions, and ulcerations [9]. It thus hinders a proper evaluation of the mucosa; i.e., flat advanced adenomas are difficult to detect, even by experienced endoscopists.

Previous studies [4, 10, 11] found that pre-operative colonic evaluation identified only an irrelevant number of pathologies and concluded them to be futile. Within the framework of this study, we thus intend to determine the incidence and clinical consequences of findings in commonly scheduled pre-reversal endoscopies of the whole colon, with special interest in asymptomatic patients, as currently there is no clear evidence of impact on subsequent therapy [3, 4, 12]. We hypothesized the sole endoscopic evaluation of the anastomotic integrity in asymptomatic patients to be sufficient prior to reversal, considering that a complete exploration of the colonic mucosa could be planned combined with the necessary follow-up consultation 2–3 months after ostomy closure.

Materials and Methods

Study Design

Using the hospital inherent computerized medical records database (KISIM, CISTEC AG, Zurich, Switzerland), we retrospectively identified 236 patients (female, $n=91$) with a total of 279 ostomy installations that were followed up at the departments of gastroenterology and / or surgery of the University Hospital of Zurich (USZ) with regards to ostomy reversal between January 2002 and December 2020. Collection of personal patient data and the scientific work-up were approved and performed conforming to the guidelines and regulations of the research ethics committee (KEK-ZH-Nr. 2019-00208) and collection of the patients' written informed consent was waived.

Figure 1 gives an overview of the patient selection. In 28 patients, more than one ostomy formation was performed. In these patients, pre-operative endoscopic examination of only the first documented ostomy formation were included in this study. Examination results of any following study of the same patient were excluded. We further precluded those without documented endoscopic examination prior to potential ostomy closure ($n=47$ cases) and those where endoscopic evaluation was performed before ostomy formation and not repeated prior to take-down surgery ($n=17$ cases). These 17 cases were analyzed separately (see Supplementary Table 1).

The defined interdisciplinary approach at our institution consists of an endoscopy performed prior to ostomy reversal; only in case of distinctive symptoms, additional cross-sectional imaging or contrast studies are complemented.

We retrieved data from surgery, anesthesia, clinical follow-up, colonoscopy or flexible sigmoidoscopy reports, and patients' discharge papers. Medical records were reviewed for patient demographics, ASA score, previous abdominal operations, indication for ostomy formation, stoma characteristics, as well as for data from additional examinations, including imaging and endoscopy.

We further reported whether patients presented with any symptoms, whether they were endoscopically assessed prior to reversal surgery, what the findings were with regards to mucosal and anastomotic integrity and of utmost interest, and whether these had impacted change in surgical procedures.

Relevant symptoms reported by the patients as provided by the consultation reports were defined as such potentially related to impaired conditions of the colonic mucosa or anastomotic integrity: a patient complaining of parastomal pruritus / erythema / hernia or high-output stoma was, for instance, not classified as symptomatic, whereas one suffering from obstipation / low-output stoma / mechanical intestinal obstruction or bleeding out of stoma stump was considered symptomatic with potentially related endoscopic findings.

Endoscopic findings were classified as 1) anastomotic stenosis or anastomotic / stump leakage (defined as a leak of luminal contents from a surgical joint resulting from the reopening of a surgical suture or the formation of an abscess, fistula or sinus), 2) benign (i.e., ulcerations, fistulas, low-risk polyps (size < 10 mm, low-grade dysplasia), inflammatory changes), or as 3) malignant lesions (including high-grade adenoma (defined as ≥ 10 mm in size and / or associated with high-grade dysplasia)). If present, diversion colitis was documented, but not regarded as a relevant finding per se, since it would not change planned surgical management.

The endoscopy's quality was objectively rated by means of the Boston Bowel Preparation Scale (BBPS) score [13]. The original BBPS is not applicable for flexible sigmoidoscopies.

Data extraction was processed by a single investigator to ensure consistency.

Outcomes

Primary composed endpoint was the assessment of a pre-reversal endoscopy's necessity in asymptomatic patients by determining the incidence of endoscopically identified pre-operative relevant pathological findings and its impact on operative decision-making.

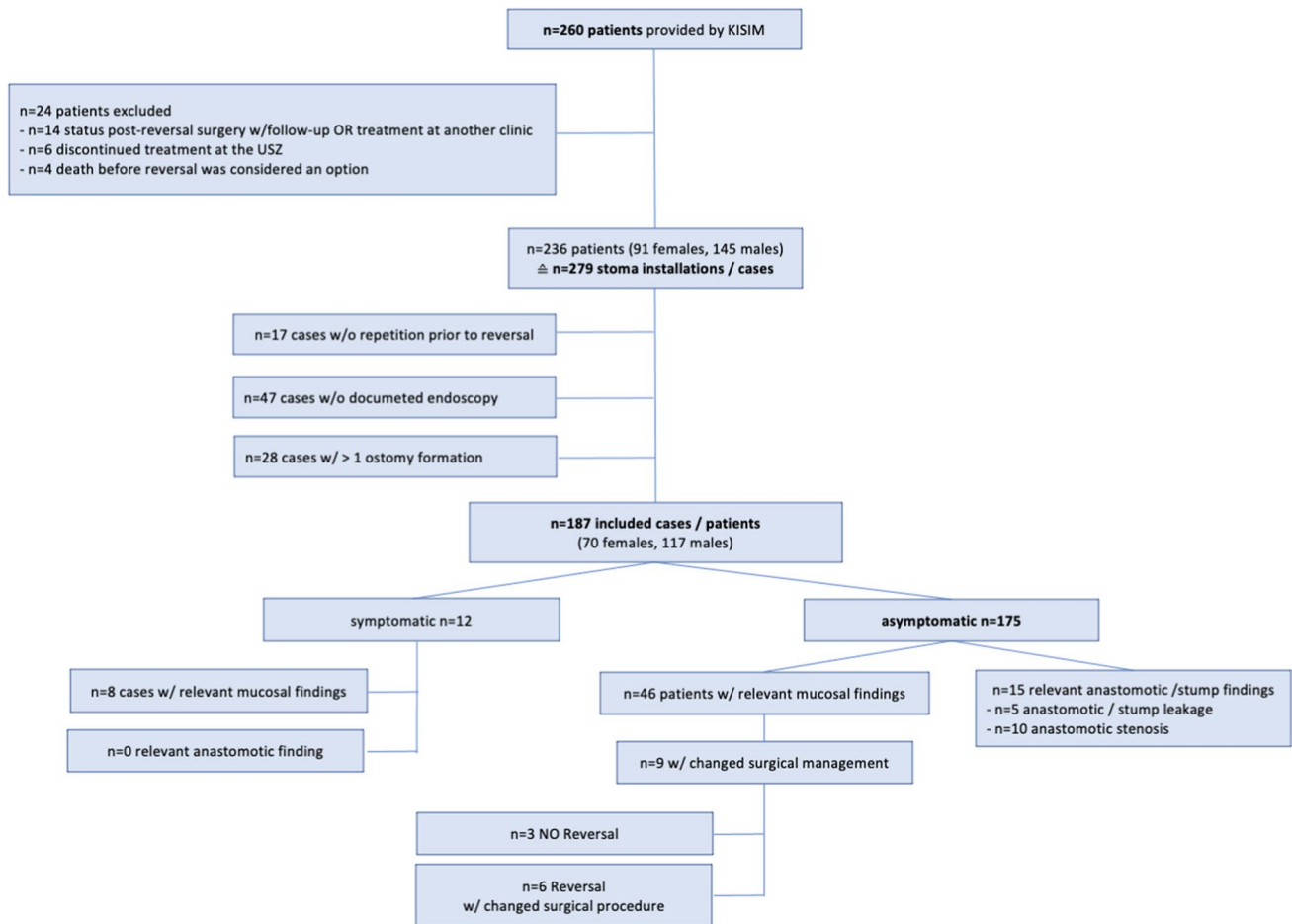


Fig. 1 Flowchart of patient/case selection

Secondary endpoints were the endoscopic evaluation of the anastomosis’/stumps’ integrity and the identification of patient characteristics ultimately predicting a potential benefit from a pre-reversal endoscopy.

Statistics

Statistical significance was defined as $p < 0.05$. Results are expressed as mean \pm standard deviation (SD) or median \pm interquartile range (IQR) and were compared by Student’s *t* test or Wilcoxon’s rank sum test, as appropriate. Normal distribution of data was assessed with Shapiro–Wilk test. To identify potential factors influencing whether a pre-reversal endoscopy benefited an asymptomatic patient, binary logistic regression and respective odds with 95% confidence intervals (CI) were computed. *R* V4.0.2 and *R*-Studio V1.3.1093 (R Foundation for Statistical Computing, Vienna, Austria) were used for statistical analyses, calculations, and graphical representations.

Results

Cohort and Endoscopic Findings

A total of 187 patients / cases met criteria for inclusion. Table 1 provides baseline data.

Endoscopic examinations were either performed at our institution ($n = 154$ studies, 82%) or at a referral private practice ($n = 33$ studies, 18%). As shown in Table 2, endoscopic examinations reported relevant findings of the bowel mucosa in 28.9% of 187 cases and of the anastomotic site in 8.2% of all 183 cases with an anastomotic or stump site.

Examinations of asymptomatic patients at the time of endoscopy ($n = 175$ cases) revealed at least one relevant mucosal finding in 26.3% of patients, namely 13 histologically confirmed and 8 suspected low-grade adenomas, 23 other benign findings (i.e., fistulas, ulcerations, inflammatory changes), 5 stenosis/strictures of adjacent bowel segments, and 1 high-grade adenoma with transition into carcinoma. Findings at the anastomotic or stump site were detected in 8.7% of all asymptomatic cases (5 leakages and 10 stenoses) and 5 cases

Table 1 Baseline patient demographic data

	Double barrel ileostomy (<i>N</i> = 143)	End Jejuno-/ileostomy (<i>N</i> = 11)	Double barrel colostomy (<i>N</i> = 6)	End colostomy (<i>N</i> = 27)	Total (<i>N</i> = 187)
Gender					
Female	58 (40.6%)	4 (36.4%)	0 (0.0%)	8 (29.6%)	70 (37.4%)
Male	85 (59.4%)	7 (63.6%)	6 (100.0%)	19 (70.4%)	117 (62.6%)
Age (years)					
Mean (SD)	60.4 (14.2)	50.9 (18.7)	65.3 (14.1)	59.3 (17.2)	59.8 (15.0)
Median [Q1, Q3]	62.0 [52.0, 71.0]	60.0 [38.0, 64.0]	65.0 [54.8, 72.3]	63.0 [49.5, 71.0]	61.0 [51.0, 71.0]
BMI					
Mean (SD)	24.6 (4.60)	23.4 (4.27)	26.5 (3.27)	27.1 (6.29)	24.9 (4.88)
Median [Q1, Q3]	23.8 [21.3, 27.1]	23.2 [20.8, 25.3]	26.5 [24.8, 27.9]	26.6 [22.2, 28.7]	24.3 [21.5, 27.6]
No data	2 (1.4%)	0 (0%)	0 (0%)	2 (7.4%)	4 (2.1%)
ASA score					
1	1 (0.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.5%)
2	86 (60.1%)	9 (81.8%)	5 (83.3%)	14 (51.9%)	114 (61.0%)
3	54 (37.8%)	2 (18.2%)	1 (16.7%)	11 (40.7%)	68 (36.4%)
4	1 (0.7%)	0 (0.0%)	0 (0.0%)	2 (7.4%)	3 (1.6%)
Missing	1 (0.7%)	0 (0%)	0 (0%)	0 (0%)	1 (0.5%)
Previous abdominal operation (s)					
No	71 (49.7%)	5 (45.5%)	3 (50.0%)	12 (44.4%)	91 (48.7%)
Yes	72 (50.3%)	6 (54.5%)	3 (50.0%)	15 (55.6%)	96 (51.3%)
Symptoms					
No	136 (95.1%)	9 (81.8%)	5 (83.3%)	25 (92.6%)	175 (93.6%)
Yes	7 (4.9%)	2 (18.2%)	1 (16.7%)	2 (7.4%)	12 (6.4%)
Reason for stoma					
Colitis ulcerosa	2 (1.4%)	6 (54.5%)	0 (0.0%)	0 (0.0%)	8 (4.3%)
M. Crohn	9 (6.3%)	0 (0.0%)	0 (0.0%)	3 (11.1%)	12 (6.4%)
Anal carcinoma	3 (2.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (1.6%)
Rectum carcinoma	44 (30.8%)	0 (0.0%)	2 (33.3%)	1 (3.7%)	47 (25.1%)
Colon carcinoma	20 (14.0%)	1 (9.1%)	1 (16.7%)	2 (7.4%)	24 (12.8%)
Anastomotic insufficiency	7 (4.9%)	1 (9.1%)	1 (16.7%)	0 (0.0%)	9 (4.8%)
Ischemia	4 (2.8%)	1 (9.1%)	0 (0.0%)	2 (7.4%)	7 (3.7%)
Intestinal perforation	8 (5.6%)	0 (0.0%)	1 (16.7%)	6 (22.2%)	15 (8.0%)
Mechanical intestinal obstruction	4 (2.8%)	1 (9.1%)	1 (16.7%)	1 (3.7%)	7 (3.7%)
Perforated sigma diverticulitis	15 (10.5%)	0 (0.0%)	0 (0.0%)	8 (29.6%)	23 (12.3%)
Protective	4 (2.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4 (2.1%)
Other	23 (16.1%)	1 (9.1%)	0 (0.0%)	4 (14.8%)	28 (15.0%)
Endoscopic study					
Colonoscopy	74 (51.7%)	5 (45.5%)	5 (83.3%)	24 (88.9%)	108 (57.8%)
Recto-sigmoido	69 (48.3%)	6 (54.5%)	1 (16.7%)	3 (11.1%)	79 (42.2%)
Endoscopy location					
In-house	116 (81.1%)	11 (100.0%)	2 (33.3%)	25 (92.6%)	154 (82.4%)
External	27 (18.9%)	0 (0.0%)	4 (66.7%)	2 (7.4%)	33 (17.6%)
Complications—Clavien–Dindo Scale					
0	84 (58.7%)	5 (45.5%)	3 (50.0%)	9 (33.3%)	101 (54.0%)
1	16 (11.2%)	1 (9.1%)	1 (16.7%)	0 (0.0%)	18 (9.6%)
2	23 (16.1%)	2 (18.2%)	2 (33.3%)	6 (22.2%)	33 (17.6%)
3a	3 (2.1%)	1 (9.1%)	0 (0.0%)	2 (7.4%)	6 (3.2%)
3b	11 (7.7%)	2 (18.2%)	0 (0.0%)	4 (14.8%)	17 (9.1%)
4a	1 (0.7%)	0 (0.0%)	0 (0.0%)	1 (3.7%)	2 (1.1%)

Table 1 (continued)

	Double barrel ileostomy (<i>N</i> = 143)	End Jejuno-/ileostomy (<i>N</i> = 11)	Double barrel colostomy (<i>N</i> = 6)	End colostomy (<i>N</i> = 27)	Total (<i>N</i> = 187)
4b	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (3.7%)	1 (0.5%)
5	1 (0.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.5%)
No data	4 (2.8%)	0 (0%)	0 (0%)	4 (14.8%)	8 (4.3%)
CCI					
Mean (SD)	10.7 (18.0)	16.1 (20.0)	8.37 (10.2)	22.6 (22.1)	12.5 (18.9)
Median [Q1, Q3]	0 [0, 20.9]	8.70 [0, 23.6]	4.35 [0, 17.6]	20.9 [0, 38.0]	0 [0, 20.9]
No data	4 (2.8%)	0 (0%)	0 (0%)	4 (14.8%)	8 (4.3%)
Length of hospital stay (days)					
Mean (SD)	11.9 (17.0)	15.2 (15.6)	11.2 (4.62)	14.5 (8.88)	12.4 (15.8)
Median [Q1, Q3]	6.00 [5.00, 13.0]	10.0 [5.50, 15.0]	9.50 [9.00, 11.5]	13.0 [8.00, 19.0]	7.00 [5.00, 14.0]
No data	4 (2.8%)	0 (0%)	0 (0%)	4 (14.8%)	8 (4.3%)

As total of the whole cohort and separate per stoma type

SD standard deviation, *Q* quartile

were not assessable by means of endoscopic examination due to either unpassable stenosis or inadequate bowel preparation.

In 12 cases, patients complained of symptoms suggestive of a pathology affecting the colonic mucosa or anastomosis / stump, which indeed held true in 8 examinations (66.6%; *n* = 2 low-grade adenomas, *n* = 4 other benign findings, *n* = 1 stenosed bowel segment, *n* = 1 suspected benign polyp, *n* = 1 suspected colon carcinoma) and entailed change in management in 4 cases (33.3%; *n* = 1 no reversal, *n* = 1 change in surgical procedure, *n* = 2 additional imagery necessary).

Endoscopy Quality

Considering all documented endoscopies (*n* = 187), we found indicative signs of diversion colitis or proctitis documented in 88 (47.0%) studies, more specifically in 61 (56.5%) colonoscopies and 27 (34.2%) flexible sigmoidoscopies.

Of the total 154 endoscopic studies performed at the gastroenterological department of our institution, 85 were colonoscopies and 69 flexible sigmoidoscopies. 24.7% of colonoscopies (*n* = 23) featured a BBPS Score of 5 and under. We found no statistically significant difference (*p* = 0.43) in median BBPS Scores comparing colonoscopies revealing mucosal findings (median 7.0, IQR 1.0) and those revealing none (median 6.0, IQR 3.0).

Impact of Endoscopic findings in Asymptomatic Patients

A change in subsequent patient management in at least one aspect (i.e., change in surgical procedure, further imagery after endoscopic evaluation, dilatation of stenosis) was noted

in 18 of all asymptomatic cases (10.3%; supplementary table 2).

Additional imaging for a more detailed assessment of the discovered endoscopic findings was deemed necessary in a total of 7 cases. Another four cases had to undergo dilation of the anastomosis prior to definitive take-down surgery.

Pre-reversal endoscopy effectively changed the planned surgical management in 9 of all asymptomatic cases (5.1%): *n* = 3 patients were advised against ostomy take-down surgery due to persistent anastomotic or stump leakages (*n* = 2) and pronounced stenosis (*n* = 1); in 3 patients benign lesion were resected (anal polyp, *n* = 1; intestinal segment containing a fistula, *n* = 2); in 2 patients stenosed bowel segments were resected; and one patient had to undergo low anterior resection due to a high-grade rectal adenoma with transition to carcinoma.

Hence, the pre-reversal endoscopic finding of a polyp changed the course of surgical management in only two patients, namely (1) a 38-year-old female patient with initially diagnosed anal carcinoma, in which case the endoscopically identified polyp was resected at the time of ostomy reversal surgery and (2) a 66-year-old male patient following perforated sigma diverticulitis with histologically confirmed high-grade adenoma and transition into carcinoma who consequently underwent low anterior resection surgery in addition to ostomy reversal.

Independently of the pre-reversal endoscopy, ostomy reversal was not carried out in seven cases due to patient's wishes and in two cases the patient had died prior to take-down surgery.

Of the 47 excluded cases due to lacking documentation of endoscopic examination, 44 cases were asymptomatic. Of those, ten effectively had a change in surgical

Table 2 Pre-reversal endoscopic studies of bowel mucosa and anastomotic site—findings

Endoscopic evaluation of bowel mucosa (<i>n</i> = 187 cases)			
All			
No relevant findings	133 patients [71.1%]		
Relevant findings	54 patients [28.9%]		
Stenosis of bowel segment	6 cases [3.2%]		
Benign adenoma	15 cases [8.0%]		
Benign other	27 cases [14.4%]		
Suspected benign polyps*	9 cases [4.8%]		
Malignant	2 cases [1.1%]		
Asymptomatic cases	175	Symptomatic cases	12
No relevant findings	129 patients [73.7%]		4 patients [33.3%]
Relevant findings	46 patients [26.3%]		8 patients [66.6%]
Stenosis of bowel segment	5 cases [2.9%]		1 case [8.3%]
Benign adenoma	13 cases [7.4%]		2 cases [16.7%]
Benign other	23 cases [13.1%]		4 cases [33.3%]
Suspected benign polyps*	8 cases [4.6%]		1 case [8.3%]
Malignant	1 cases [0.6%]		1 case [8.3%]
Endoscopic evaluation of anastomosis/stump (<i>n</i> = 183 cases)			
All			
Intact	163 patients [89.1%]		
Intact anastomosis	138		
Intact stump	25		
Anastomotic/stump leakage	5 Patients [2.7%]		
Anastomotic stenosis	10 Patients [5.5%]		
Not assessable	5 Patients [2.7%]		
Asymptomatic cases	171	Symptomatic cases	12
Intact	151 Patients [88.3%]	12 Patients [100%]	
Intact anastomosis	128		10
Intact stump	23		2
Anastomotic/stump leakage	5 Patients [2.9%]		0 Patients [0%]
Anastomotic stenosis	10 Patients [5.8%]		0 Patients [0%]
Not assessable	5 Patients [2.9%]		0 Patients [0%]

*No polypectomy during endoscopy and thus no histological work-up of the lesions

management and did not undergo reversal surgery (*n* = 2 patient’s wishes, *n* = 2 deceased before operation, *n* = 2 lacking further documentation, *n* = 4 not recommended (*n* = 1 due to recurrent colitis episodes; *n* = 1 polymorbidity; *n* = 1 bad odds requiring reversal surgery; *n* = 1 reason not documented)).

Using logistic regression, we found the ages of 51 to 60 years old (but not gender, BMI, ASA Score, or the patient’s underlying medical conditions (e.g., IBD or history of cancer)) in asymptomatic cases to be significantly predictive of relevant endoscopic findings (Fig. 2).

Discussion

Formation of temporary diverting ostomies is considered a low-risk procedure primarily performed to mitigate the risk of an anastomotic leak and its ensuing complications (3, 4, 14–16). Endoscopic evaluation of the diverted bowel segment is commonly performed at many institutions to ensure the absence of any pathology possibly affecting the anastomotic or mucosal integrity prior to ostomy closure.

As a main result of this study, we found that pre-reversal endoscopic studies revealed relevant pathological findings of the bowel mucosa in a little less than a third of all and in 26.3% of asymptomatic cases. However, only a

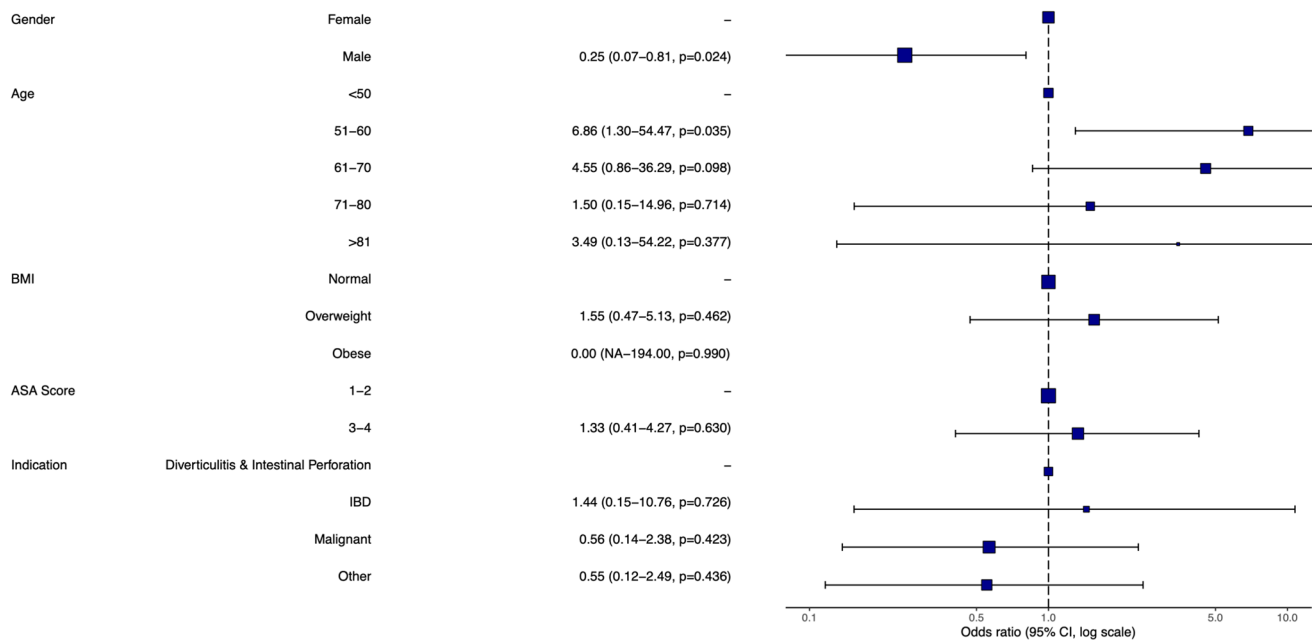


Fig. 2 Impact of endoscopy in asymptomatic patients. Graphical representation of logistic regression results regarding patient characteristics linked to relevant endoscopic findings impacting change in

patient management. Blue squares indicated logistic odds compared to reference levels with error bars showing 95% CI

small fraction ($n=9$ patients; 5.1%) seem to matter with regards to ostomy closure within the asymptomatic cohort. In addition, our results demonstrate that patients without gastrointestinal symptoms at the time of pre-reversal endoscopy have noticeably less relevant findings compared to symptomatic patients (26.3% vs. 66.6%). Similarly, Cherukuri et al. found abnormal findings in only 16% of asymptomatic patients (11/70) with a Hartmann's pouch in contrast-enhanced radiologic studies; of note, 3 of the 11 patients had signs of diversion colitis, which is somehow expected in bowel segments distal of a stoma [12].

Within the framework of our study, we found the incidence of low-grade adenomas in the asymptomatic cohort to lie at 12% (7.4% of those histologically confirmed). It is known that adenomas arising at the ileostomy site often coincide with the presence of a stomal prolapse, are mostly found at the mucocutaneous anastomosis, and commonly occur after an interval of over 10 years following stoma installation, thus justifying the execution of periodic endoscopy and biopsy in patients with long-standing ileostomies [17, 18]. However, benign lesions smaller than 2 cm in size do not justify pre-reversal endoscopy.

Although we found no significant difference in median BBPS score comparing endoscopic studies exhibiting findings with those revealing none, one must acknowledge that the lower the score, the higher the percentage of unremarkable (and thus possibly false negative) endoscopic studies. Considering a score ≤ 5 is deemed insufficient [13], 23 out of

our 85 (24.7%) documented in-house colonoscopies would, in theory, have had to be redone prior to ostomy closure. However, this held true in only six cases, questioning the pre-reversal endoscopic evaluation even more. Inadequate bowel preparation is an irrefutable fact linked to diversion colitis arising from fecal diversion and impairing endoscopic visibility due to the large amount of mucus. In most cases like these, however, endoscopic re-evaluation will be performed postoperatively, for instance, during a follow-up consultation 2–3 months after reversal surgery, where incidental findings such as diversion colitis will no longer be of issue, thus guaranteeing better bowel preparation and endoscopic quality, in the frame of which possible adenomas and early stages of cancer may be endoscopically resected. Our suggestion would further correspond with BSG/PHE/ACPGBI as well as our national SGGSSG guidelines, stating that surveillance by means of colonoscopy is to take place within a year after cancer resection surgery [19, 20].

In our cohort, anastomotic or stump leaks were found in 2.7% of the 183 patients with an anastomotic or stump site, all of which clinically silent. This is comparable to the findings collected by Park et al., who reported the leakage rate to range from 2.0 to 10.3% [21]. Why these cases remained clinically silent poses an interesting question – Ferko et al. have suggested that leaks “hidden” behind / i.e., in the setting of a diverting ostomy may contribute to the repression or discreet manifestation of symptoms [22]. Chambers and Mortensen even recommend differentiating major from

minor anastomotic leakages, the latter being asymptomatic and only evident upon imaging studies [23].

Studies have shown that diagnosing an anastomotic leakage is essential, as failing to do so results in a significantly higher overall rate and number of complications, thus encumbering quality of life, as well as a higher mortality [24, 25]. Although current clinical practice includes abdominal imaging by means of CT-scan and rectal contrast radiography, there is still no gold standard modality for the diagnosis of an anastomotic leakage. Researchers are currently trying to identify biomarkers, such as ischemic metabolites, inflammatory markers, and bacterial components, enabling postoperative monitoring of intestinal healing, thus identifying patients at a high risk of developing an anastomotic leakage [26]. Currently, since findings of leakage or stenosis in cross-sectional imaging or contrast radiography are subsequently re-evaluated by means of an endoscopic study, we suggest the latter to be the standard with regards to pre-operative anastomotic evaluation. Especially in patients with low anastomosis, sigmoidoscopy and digital rectal examination are not inferior to contrast studies [10, 27]. Whether or not a reversal is then performed, despite the persistent existence of a radiologic or endoscopic leakage, remains within the surgeon's judgment [28].

We further set out to determine the clinical significance of abnormal endoscopic findings in asymptomatic (no gastrointestinal symptoms prior to elective ostomy closure) patients and whether they had influence on the planned surgical management. Out of the 175 assessed asymptomatic cases, we found that only 5.1% of all endoscopic studies effectively entailed a change in surgical procedure. This is in line with findings of Ballian et al., who documented an altered patient management in only 3 of 135 patients (2%) undergoing Hartmann's reversal following abnormal pre-operative endoscopic evaluation ($n = 10$) [4]. Our findings are further corroborated by another study discovering abnormal results in 12.2% of the patients undergoing colonic pre-operative evaluation by means of contrast enema prior to ileostomy closure, whereby a change in patient management was solely noted in 4 cases (4.1%) [11]. Moreover, abnormal pre-operative study findings were not associated with an impaired postoperative outcome, nor with a significant difference in postoperative outcomes between patients with and without pre-operative colonic evaluation [11].

These results underline our analysis of 17 patients that were excluded from the present study due to no pre-ostomy closure endoscopy (supplementary table 1). A post-reversal endoscopy was documented in 12 of those cases (70.6%) at a median interval of 82.5-day post-ostomy closure. Despite the small sample size, the value of a pre-ostomy closure endoscopy just to rule out a malignant lesion has to be questioned, since we found only one malignancy (patient 10). In the remaining four cases in which findings were ascertained

by biopsy or excision, the results were all benign. Within the scope of a similar study, a more extensive (in terms of number of patients) and definitive enquiry and analysis of these observations may be of future value.

Our calculations, using logistic regression, revealed that patients within the age range of 51 to 60 years old would most likely benefit from an endoscopic evaluation prior to ostomy closure. This, again, correlates with our national SGGSSG guidelines [19, 20].

In contrast to asymptomatic patients, patients displaying symptoms possibly related to colorectal pathologies should indeed undergo endoscopic investigation prior to takedown surgery. Relevant findings were documented upon endoscopic examination in two-thirds of the symptomatic case cohort ($n = 8$ patients), impacting change in further management in up to 50% and change in surgical procedure in 12.5% of cases. This is in line with a previous study, which reported a change in management in all five cases which were clinically symptomatic and additionally showed abnormal contrast studies [12], as well as Haas et al. who described having found, among other pathologies, eight carcinomas and two polyps in patients exhibiting abdominal pain and / or rectal bleeding [29].

This study is limited by its retrospective, single-center nature and the inherent potential biases associated with such a design. We also do not present data on the complication rate of the performed endoscopic studies – however, we are not aware of any serious side effects and in general, complication rates of colonoscopies are rare [30]. Furthermore, we did not analyze post-reversal outcomes and the potential correlation to endoscopic pre-reversal findings with regards to clinical relevance of endoscopic examination prior to takedown surgery. We also do not provide data on colonoscopies performed prior to stoma formation surgery, except in the case of the eighteen studies which were separately analyzed.

Conclusion

The relevance of planned endoscopic studies in asymptomatic patients prior to ostomy closure remains undefined. Our findings strongly suggest stoma take-down surgery without previous endoscopic assessment of the entire colon in asymptomatic patients to be acceptable. We do however find the evaluation of the colon mucosa to be indicated in all patients meeting the screening criteria for colorectal carcinoma. To reach a high-quality screening colonoscopy, this should be done in the interval after successful restoration of the colon allowing proper bowel preparation.

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Author's contribution MT and CG served as the primary investigator of the study. MES, MAS, FRM, MT, and CG made substantial contributions to the study conception and design. MES acquired the data. MES and MAS performed statistical analyses and data interpretation, calculations, and graphical illustrations. All authors wrote the manuscript and contributed to revision of the manuscript and final approval for publication.

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Declarations

Conflict of interest Maxine Schreiber, Marcel Schneider, Fritz Murray, Matthias Turina, and Christoph Gubler have no conflicts of interest or financial ties to disclose.

Ethical approval The study adhered to and was conducted according to the principles of the Declaration of Helsinki and current good clinical practice guidelines. The protocol was approved by the responsible ethics committee of the canton of Zurich, Switzerland (KEK-ZH-Nr. 2019–00208). Collection of patients' written consent was waived.

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