Incidence of and risk factors for stoma-site incisional herniation after reversal

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Background: Stoma reversal is often considered a straightforward procedure with low short-term complication rates. The aim of this study was to determine the rate of incisional hernia following stoma reversal and identify risk factors for its development.

Methods: This was an observational study of consecutive patients who underwent stoma reversal between 2009 and 2015 at a teaching hospital. Patients followed for at least 12 months were eligible. The primary outcome was the development of incisional hernia at the previous stoma site. Independent risk factors were assessed using multivariable logistic regression analysis.

Results: After a median follow-up of 24 (range 12–89) months, 110 of 318 included patients (34·6 per cent) developed an incisional hernia at the previous stoma site. In 85 (77·3 per cent) the hernia was symptomatic, and 72 patients (65·5 per cent) underwent surgical correction. Higher BMI (odds ratio (OR) 1·12, 95 per cent c.i. 1·04 to 1·21), stoma prolapse (OR 3·27, 1·04 to 10·27), parastomal hernia (OR 5·08, 1·30 to 19·85) and hypertension (OR 2·52, 1·14 to 5·54) were identified as independent risk factors for the development of incisional hernia at the previous stoma site. In addition, the risk of incisional hernia was greater in patients with underlying malignant disease who had undergone a colostomy than in those who had had an ileostomy (OR 5·05, 2·28 to 11·23).

Conclusion: Incisional hernia of the previous stoma site was common and frequently required surgical correction. Higher BMI, reversal of colostomy in patients with an underlying malignancy, stoma prolapse, parastomal hernia and hypertension were identified as independent risk factors.

Introduction

Stoma reversal is often regarded as a straightforward and safe surgical procedure with low short-term postoperative morbidity and mortality rates[1]. The stoma incision site, however, is at risk for the development of incisional hernia[2]. Earlier studies[3–5] estimated the incidence of incisional hernia following stoma reversal as approximately 7 per cent. More recent studies[6–8], designed specifically to investigate stoma-site herniation, have reported a considerably higher incidence of 30–35 per cent. Incisional hernia following stoma closure may therefore be an underestimated clinical problem, causing abdominal pain, discomfort and impaired quality of life[6]. Medical consultation is often sought. Approximately 50 per cent of patients require surgical correction to relieve symptoms[6]. Hernia repair is often considered a high-risk procedure due to co-morbidities and intra-abdominal adhesions from previous abdominal surgery[9,10]. The rate of incisional hernia at the stoma site seems to be much higher than rates of herniation following other abdominal incisions (10–15 per cent)[11,12].

Further investigation of risk factors is warranted[12]. This could lead to new strategies for prevention of hernia in high-risk patients. Prophylactic mesh placement at the previous stoma site during stoma closure may markedly decrease the risk of incisional hernia development[6,13]. It does, however, increase medical costs per procedure and
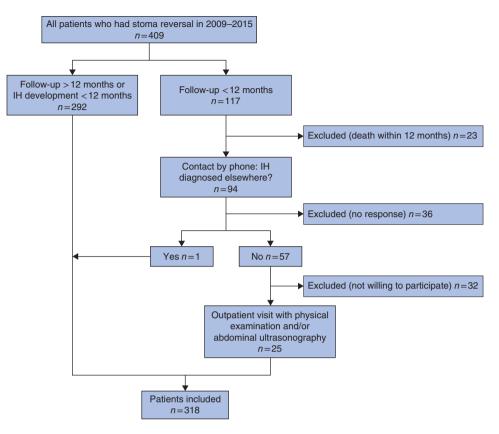
Fig. 1 Overview of patient selection. IH, incisional hernia

may increase the risk of surgical-site infection (SSI)[14]. The aim of this study was to quantify accurately the incidence of and identify risk factors for incisional hernia at the previous stoma site following reversal.

Methods

This was an observational study involving consecutive patients who underwent stoma reversal between January 2009 and December 2015 at a teaching hospital in the Netherlands. Patients were identified by operation code in the hospital's electronic medical system. Patients older than 18 years were analysed when they underwent reversal of an ileostomy or colostomy and had follow-up longer than 12 months or an incisional herniation was observed.

Guidelines for oncological follow-up in the Netherlands include outpatient visits at 6-month intervals for the first 2–3 years and once a year until 5 years after resection. CT or abdominal ultrasound imaging is done 6 months after resection, and then on a yearly basis[15]. Medical records were retrieved to see whether incisional hernia was identified by physical examination, CT or ultrasonography during follow-up. Patients whose clinical or radiological follow-up (CT or ultrasound imaging) was less than 12 months after stoma reversal were contacted and asked whether the diagnosis of an incisional hernia had been made in another hospital or by their general practitioner. When the diagnosis was considered correct, two additional questions were asked, including when the hernia was diagnosed and whether or not the patient had undergone surgical correction. If incisional hernia had not been diagnosed at that time, the patient was invited to the outpatient clinic for physical examination of the previous stoma site. Any palpable defect was recorded. When it was clinically unclear, abdominal ultrasonography was performed in the supine position during a Valsalva manoeuvre.

All stoma reversals were performed under general anaesthesia. All patients received prophylactic antibiotics (cefmetazole 1 g and metronidazole 500 mg). An incision was made around the stoma, and the bowel was mobilized from surrounding tissues. In patients with a loop stoma, intestinal continuity was restored without the need for an additional laparotomy. When patients had an end stoma, laparotomy or laparoscopy was necessary to restore bowel

Table 1 Baseline characteristics

	Total ($n = 318$)	Hernia ($n = 110$)	No hernia ($n = 208$)	P§
Age (years)*	61·7 (53–72)	61·7 (52–73)	61·7 (54–71)	0·992¶
Sex ratio (M : F)	170 : 148	52 : 58	118 : 90	0·108
BMI (kg/m²)*	26 (23–30)	27·2 (23·5–32·5)	25·5 (22–28)	< 0·001¶
ASA fitness grade				0·700
I–II	286 (89·9)	98 (89·1)	188 (90·4)	
III–IV	32 (10·1)	12 (10·9)	20 (9·6)	
Indication for stoma construction				0·001
Protection of anastomosis	194 (61·0)	51 (46·4)	143 (68·8)	
Anastomotic leak	25 (7·9)	10 (9·1)	15 (7·2)	
Acute colonic obstruction	52 (16·4)	24 (21·8)	28 (13·5)	
Other benign condition†	47 (14·8)	25 (22·7)	22 (10·6)	
Underlying malignant disease	191 (60·1)	48 (43·6)	143 (68·8)	< 0·001
Current smoker	66 (20·8)	24 (21·8)	42 (20·2)	0·665
Preoperative haemoglobin (mmol/l)*	7·9 (7·2–8·5)	8·1 (7·3–8·5)	7·8 (7·1–8·4)	0·140¶
Co-morbidity				
Hypertension	106 (33·3)	47 (42·7)	59 (28·4)	0·012
Diabetes mellitus	41 (12·9)	15 (13·6)	26 (12·5)	0·861
COPD	22 (6·9)	6 (5·5)	16 (7·7)	0·643
Cardiovascular disease	69 (21·7)	28 (25·5)	41 (19·7)	0·254
Primary abdominal surgery				0·796
Open	138 (43·4)	49 (44·5)	89 (42·8)	
Laparoscopic	160 (50·3)	53 (48·2)	107 (51·4)	
n.a.‡	20 (6·3)	8 (7·3)	12 (5·8)	
Primary resection type				0·131
Left hemicolectomy	22 (6·9)	10 (9·1)	12 (5·8)	
Right hemicolectomy	13 (4·1)	4 (3·6)	9 (4·3)	
Subtotal colectomy	19 (6·0)	7 (6·4)	12 (5·8)	
Sigmoidectomy	101 (31·8)	43 (39·1)	58 (27·9)	
Low anterior resection	143 (45·0)	38 (34·5)	105 (50·5)	
n.a.‡	20 (6·3)	8 (7·3)	12 (5·8)	
Adjuvant therapy	49 (15·4)	11 (10·0)	38 (18·3)	0·071
Emergency surgery	87 (27·4)	39 (35·5)	48 (23·1)	0·024

Values in parentheses are percentages unless indicated otherwise; *values are median (i.q.r.). †Includes diverticulitis, slow-transit colon and anal fistula. ‡Stoma construction was the primary surgery with no subsequent resection (anal fistula). COPD, chronic obstructive pulmonary disease, n.a., not available. §χ^2 or Fisher's exact test, except ¶Mann–Whitney U test.

continuity. Anastomosis was created by a double-stapling technique for loop stomas and with a circular stapler for end stomas. The fascia defect was closed primarily with either continuous or interrupted absorbable sutures. The skin was closed using a purse-string technique[16]. All procedures were performed or supervised by one of four experienced gastrointestinal surgeons.

Data collected from the patients' medical records included patient characteristics (age at stoma-site closure, sex, BMI, ASA grade, smoking behaviour), co-morbidities (diabetes, chronic obstructive pulmonary disease, hypertension (defined as a systolic BP above 140 mmHg on more than three consecutive occasions), cardiovascular disease, previous abdominal surgery), surgical variables (operative technique, material and technique of sutures for fascia closure, preoperative haemoglobin, duration of hospital stay during stoma construction and reversal), stoma characteristics (colostomy or ileostomy, loop or

end, indication for stoma), complications after reversal (reintervention, SSI, anastomotic leakage, postoperative ileus), and complications while the stoma was *in situ* (parastomal hernia, stoma prolapse, skin irritation, SSI, dehydration, stoma obstruction, high-output stoma, pneumonia). Indication for the primary operation (benign or malignant), 30-day mortality and in-hospital mortality after stoma reversal were documented.

Endpoints

The primary outcome measure was whether or not an incisional hernia had developed at the previous stoma site. Incisional hernia was defined as a defect in the musculature and fascia detected by either physical examination, ultrasound examination or CT. Other outcomes included risk factors for stoma-site incisional hernia development identified by multivariable analysis.

Table 2 Intraoperative data and complications

	Total ($n = 318$)	Hernia ($n = 110$)	No hernia ($n = 208$)	P§
Type of stoma				0·001
Ileostomy	143 (45·0)	36 (32·7)	107 (51·4)	
Colostomy	175 (55·0)	74 (67·3)	101 (48·6)	
Type of stoma				1·000
End	282 (88·7)	98 (89·1)	184 (88·5)	
Loop	36 (11·3)	12 (10·9)	24 (11·5)	
No. of patients with a stoma-related complication	100 (31·4)	37 (33·6)	63 (30·3)	0·612
Prolapse	24 (7·5)	13 (11·8)	11 (5·3)	0·039
Parastomal hernia	18 (5·7)	10 (9·1)	8 (3·8)	0·067
Dehydration	19 (6·0)	4 (3·6)	15 (7·2)	0·313
Obstruction	17 (5·3)	5 (4·5)	12 (5·8)	0·785
Necrosis	5 (1·6)	2 (1·8)	3 (1·4)	1·000
High output	23 (7·2)	7 (6·4)	16 (7·7)	0·820
Retraction	4 (1·3)	0 (0)	4 (1·9)	0·303
Readmission for stoma-related complication	25 (7·9)	10 (9·1)	15 (7·2)	0·662
Time from stoma construction to closure (weeks)*	16 (12–30)	16 (12–31)	16 (12–30)	0·399¶
Suture material for fascia closure‡				0·759
Polydioxanone (PDS®)	57 of 284 (20·1)	21 of 100 (21·0)	36 of 184 (19·6)	
Polyglactin (Vicryl®)	227 of 284 (79·9)	79 of 100 (79·0)	148 of 184 (80·4)	
Suture technique				0·461
Intermittent	217 of 283 (76·7)	73 of 99 (73·7)	144 of 184 (78·3)	
Continuous	66 of 283 (23·3)	26 of 99 (26·3)	40 of 184 (21·7)	
Stoma closure technique				0·856
Local reversal	257 (80·8)	94 (85·5)	163 (78·4)	
Including laparotomy	45 (14·2)	14 (12·7)	31 (14·9)	
Including laparoscopy	16 (5·0)	2 (1·8)	14 (6·7)	
Complications after reversal				
Surgical-site infection	29 (9·1)	16 (14·5)	13 (6·3)	0·023
Pneumonia	17 (5·3)	9 (8·2)	8 (3·8)	0·112
Anastomotic leak	3 (0·9)	1 (0·9)	2 (1·0)	1·000
Obstruction	22 (6·9)	9 (8·2)	13 (6·3)	0·643
Death	0 (0)	0 (0)	0 (0)	1·000
Complications after reversal requiring reintervention	30 (9·4)	11 (10·0)	19 (9·1)	0·842
Duration of follow-up (months)*†	27·5 (12–48)	24 (12–48)	28 (18–48)	0·578§
Radiological follow-up > 12 months	230 (72·3)	78 (70·9)	152 (73·1)	0·388

Values in parentheses are percentages unless indicated otherwise; *values are median (i.q.r.). †The longest length of follow-up was used for this variable; this could be the longest clinical (with physical examination) or radiological (CT or abdominal ultrasound imaging) follow-up. ‡PDS® and Vicryl® both from Ethicon, Somerville, New Jersey, USA. §χ^2 or Fisher's exact test, except ¶Mann–Whitney U test.

Statistical analysis

Statistical analysis was performed using SPSS® version 23.0 (IBM, Armonk, New York, USA). All variables are expressed as median (range) values. Categorical data are presented as number and percentage, and were compared with Fisher's exact test or the χ^2 test as appropriate. Continuous variables were compared using Mann–Whitney U and Student's t test as appropriate.

Multivariable logistic regression analysis was performed to identify independent predictors of incisional hernia development following stoma reversal. Variables with $P < 0.100$ in univariable analysis were entered in multivariable logistic regression analysis, keeping a $1:10$ event per variable (EPV) ratio in mind. Several prespecified theoretically and biologically plausible interaction terms were added to the multivariable analysis to account for possible interaction. Statistical significance was set at $P < 0.050$ for all analyses.

Results

Some 409 patients underwent reversal of an ileostomy or colostomy between January 2009 and December 2015; 292 had been followed for more than 12 months or were diagnosed with a hernia before 12 months. The other 117 patients had limited follow-up. Twenty-five patients attended an outpatient clinic for further examination, so that eventually 318 patients (77·8 per cent) were analysed (*Fig. 1*).

Baseline characteristics are shown in *Table 1*. Of the 318 patients, 143 (45·0 per cent) had a temporary ileostomy and

Table 3 Multivariable logistic regression analysis of risk factors for development of incisional hernia

	Odds ratio	P
BMI	1·12 (1·04, 1·21)	0·004
Adjuvant therapy		0·457
No	1·00 (reference)	
Yes	0·63 (0·18, 2·15)	
Indication for stoma		
Protection of anastomosis	1·00 (reference)	
Anastomotic leak	0·64 (0·19, 2·17)	0·477
Acute colonic obstruction	0·53 (0·05, 5·78)	0·604
Other benign condition*	0·99 (0·13, 7·69)	0·990
Type of stoma		0·584
Ileostomy	1·00 (reference)	
Colostomy	1·36 (0·46, 4·05)	
Surgical-site infection		0·307
No	1·00 (reference)	
Yes	2·06 (0·52, 8·22)	
Prolapse		0·042
No	1·00 (reference)	
Yes	3·27 (1·04, 10·27)	
Parastomal hernia		0·020
No	1·00 (reference)	
Yes	5·08 (1·30, 19·85)	
Hypertension		0·022
No	1·00 (reference)	
Yes	2·52 (1·14, 5·54)	
Emergency surgery		0·951
No	1·00 (reference)	
Yes	1·06 (0·15, 7·73)	
Malignancy		0·779
No	1·00 (reference)	
Yes	1·18 (0·37, 3·71)	
Type of stoma in patients with malignant disease		0·034
Ileostomy	1·00 (reference)	
Colostomy	5·05 (2·28, 11·23)	

Values in parentheses are 95 per cent confidence intervals. *Includes diverticulitis, slow-transit colon and anal fistula.

175 (55·0 per cent) had a temporary colostomy. Ninety-five patients (29·9 per cent) had stoma-related complications while the stoma was *in situ*.

Intraoperative data and complications are shown in *Table 2*. Median follow-up was 24 (range 12–89) months. As most patients were followed up after resection of malignancy, radiological follow-up exceeded 12 months in 230 patients (72·3 per cent). The remaining 88 patients with follow-up of less than 12 months underwent physical examination to detect incisional hernia. Following stoma reversal, 110 patients developed an incisional hernia at the stoma incision site. The median time to hernia detection was 7 months. Eighty-three (75·5 per cent) of the 110 hernias were detected within 12 months. Incisional herniation was diagnosed in 57 patients (51·8 per cent), by physical examination, in 12 (10·9 per cent) by CT and in eight (7·3 per cent) by ultrasound imaging. In 33 patients

(30·0 per cent) the hernia was diagnosed by both physical examination and CT.

The incisional hernia was symptomatic in 85 of 110 patients (77·3 per cent); 72 (65·5 per cent) required surgical correction. Patients with a symptomatic hernia who chose not to undergo surgical correction either had minor symptoms or were helped sufficiently with non-surgical solutions such as abdominal wall support.

Several variables were identified as possible risk factors for the development of incisional hernia ($P < 0.100$ in univariable analysis). BMI, having a colostomy, stoma prolapse, parastomal hernia, SSI following stoma reversal, hypertension, undergoing adjuvant therapy, emergency stoma construction, having malignancy as underlying disease and indication for stoma construction were identified as possible risk factors and thus included in the multivariable logistic regression model. BMI, stoma prolapse, parastomal hernia, hypertension and colostomy reversal in patients with an underlying malignancy were identified as independent risk factors for the development of incisional hernia (*Table 3*). Type of stoma (colostomy *versus* ileostomy) was not a significant risk factor in patients with no underlying malignancy. Other interaction terms tested included BMI with hypertension, malignancy with wound infection, age with hypertension, and age with malignancy; none was statistically significant.

Discussion

Incisional hernia at the previous stoma site occurred in approximately one-third of patients after stoma reversal. This seems an appropriate reflection of the true patient population experiencing incisional herniation, as this was a consecutive cohort of patients who had a stoma for a variety of reasons. Many patients wished to undergo surgical correction of the hernia. Higher BMI, stoma prolapse, parastomal hernia, hypertension and colostomy reversal in patients with an underlying malignant disease were identified as independent risk factors for the development of incisional hernia.

The high rate of incisional hernia observed in this study is concordant with that observed in recent studies[6–8] that focused specifically on this problem. Older studies reported markedly lower incisional hernia rates following stoma closure[3], but tended to focus mainly on short-term outcomes (complications, anastomotic leakage) following stoma reversal. Incisional hernia rate was a secondary outcome, and registration may thus have been less precise as follow-up was short and incomplete[6].

It is notable that rates of hernia following stoma reversal were substantially higher than rates seen with midline

laparotomy wounds, of around 10 per cent[11,12]. A possible explanation could be that the fascial defect is larger in stoma wounds. In addition, the defect is oval-shaped, and closure of these specific wounds may result in increased tension on the abdominal wall compared with that associated with laparotomy incisions. Tension may impair scarring of the fascia. Furthermore, stoma reversal is considered surgery in a possibly contaminated area. This might lead to higher rates of SSI, thought to be a risk factor for incisional hernia development[17,18]. The present study did not identify SSI as an independent risk factor; this might be explained by a low incidence of SSI owing to the use of purse-string closure. This closure technique is known to decrease SSI markedly after stoma reversal[19].

It has been suggested[20] that a continuous suture technique with slowly absorbable monofilament suture material is preferred in order to prevent incisional hernias in laparotomy wounds. This preference, however, was based on the number of wound infections as primary outcome. Studies on preferred suturing materials, or whether a continuous or intermittent technique is preferred in order to prevent incisional hernia, are not available. It is known, however, that a small-bites (5 mm) suture technique is more effective than a large-bites (1 cm) technique in preventing incisional hernia[21]. Various suture techniques and materials were used in the present study, with no clear superiority for a particular technique (intermittent or continuous) or suture material. Unfortunately, it was not possible to retrieve from the surgical reports whether sutures were placed with small or large bites. The most effective closure technique for stoma wounds therefore remains unclear.

The surgical correction rate of diagnosed hernias was high in the present series compared with that in most previous reports[6]. This may be the result of longer follow-up. In addition, a surgeon examined all patients, which could have lowered the threshold for reintervention. Another study[14] with a similar follow-up also found reintervention rates of around 70 per cent.

Several previous studies have looked at possible risk factors for incisional hernia following stoma reversal. High BMI and having a temporary colostomy were identified as significant risk factors in several of these studies[6,8,22,23]. Parastomal hernia, stoma prolapse and hypertension have not been identified previously; most of these factors were not included in other studies. In addition, previous studies have had a considerably smaller sample size. Parastomal hernia or stoma prolapse increases the size of the existing fascial defect. This could further weaken the abdominal wall, making it more prone to incisional hernia development. The effects of hypertension on wound healing are less clear; possibly chronic microvascular changes

secondary to hypertension could impair adequate tissue perfusion, thereby reducing proper wound healing and contributing to possible wound dehiscence[22]. It is likely that other factors identified in previous studies, such as diabetes mellitus and wound infection, are also independent risk factors for hernia development[23]. The low incidence of these factors in the present study might explain why they were not identified.

The most important limitation of this study is its retrospective design, which is prone to selection bias. Not all patients were followed for more than 12 months with imaging. In these patients, smaller asymptomatic incisional hernias may have been missed. This could have led to an underestimation of the true incisional hernia rate[2,24].

Patients with risk factors have a higher risk of developing an incisional hernia. These patients would therefore benefit most from prophylactic measures. Stoma reversal in these high-risk patients could even be regarded as a hernia repair rather than a simple fascia closure[25]. This might indicate the placement of a (prophylactic) mesh to prevent future herniation at the stoma incision site. Several retrospective studies[6,13] of prophylactic mesh placement have shown promising results. RCTs, however, are lacking, but should be undertaken to determine whether mesh placement reduces the rate of incisional hernia at the stoma site without increasing SSIs.

Disclosure

The authors declare no conflict of interest.

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