Original article

doi:10.1111/codi.14476

Ileal pouch revision *vs* excision: short-term (30-day) outcomes from the National Surgical Quality Improvement Program

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Received 28 July 2018; accepted 14 October 2018; Accepted Article Online 16 November 2018

Abstract

Aim Ileal pouch–anal anastomosis (IPAA) failure occurs in approximately 5%–10% of patients. We aimed to compare short-term (30-day) postoperative outcomes associated with pouch revision and pouch excision using a large international database. Our null hypothesis was that there is no statistically significant difference in overall postoperative complications between patients selected for pouch revision *vs* pouch excision.

Methods Using the American College of Surgeons National Surgical Quality Improvement Program Participant User File from 2005 to 2016 we identified patients who underwent either IPAA revision via the combined abdominoperineal approach [Current Procedural Terminology (CPT) 46712] or IPAA excision (CPT 45136). Differences in baseline characteristics and short-term outcomes between groups were assessed with univariate and matched analyses.

Results We identified 593 reoperative IPAA procedures: revision group 78 (13%) and excision group 515 (86%). The groups had similar age and body mass index (kg/m^2), but the revision group had more women (65.4% *vs* 51.8%, $P = 0.02$) and fewer were on chronic steroids (3.9% *vs* 17.9%, $P = 0.0008$) relative to the excision group. Revision IPAA patients were more likely to have received a preoperative transfusion (5.1% *vs* 0.97%, $P = 0.02$). Revision and excision were associated with similar postoperative length of stay (9.3 *vs* 8.6 days, 0.44), mortality (nil *vs* 0.58%, respectively; $P = 0.99$) and short-term morbidity (34.6% *vs* 40.2%, respectively; $P = 0.88$) at 30 days.

Conclusions Pouch revision and excision have comparable short-term postoperative outcomes, but pouch excision appears to be more commonly utilized. Increased awareness of the indications for pouch revision or referral to specialized centres may improve pouch revision rates.

Keywords ulcerative colitis, Crohn's disease, ileal pouch–anal anastomosis, excision, revision, salvage

What does this paper add to the literature?
There is little if any literature available which compares short-term outcomes in patients who have undergone pouch revision *vs* pouch excision. In this large comparative National Surgical Quality Improvement Program study of 593 patients with failing ileal pouches, we observed no significant difference in short-term morbidity and other clinical outcomes regardless of the operation the patients underwent. Patients and surgeons should be reassured that pouch revision and pouch excision are comparable in terms of short-term morbidity and mortality.

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Previously presented as a digital oral presentation at the Congress of the European Crohn's and Colitis Organization, 15 February 2018, Vienna, Austria.

Introduction

Ulcerative colitis (UC) affects approximately 500 000 patients in the USA [1]. Of these, an estimated 30% will require surgical treatment for medically refractory disease (90%) or neoplasia (10%) during their lifetime [2]. In the 1980s, restorative proctocolectomy with

ileal pouch–anal anastomosis (IPAA) emerged as the preferred operation for most patients with UC, indeterminate inflammatory bowel disease, select cases of Crohn's proctocolitis without ileitis or perianal disease, diffuse familial adenomatous polyposis, and several other conditions that require total proctocolectomy [3–5]. Many studies have shown that this procedure offers excellent long-term functional results and quality of life [6–9]. The estimated long-term pouch survival rate is approximately 90%–95%, and for the < 10% of patients who develop pouch failure the ideal management must be individualized to each patient [8–10].

When faced with a failing pouch, surgical treatment options are based on the surgical indication and degree of pathology (Fig. 1, left panel), ranging from outpatient perineal procedures such as seton placement and endopouch advancement flaps, to more invasive perineal procedures such as full thickness perineal pouch advancement, to trans-abdominal procedures such as permanent re-diversion, and finally the most invasive: combined abdominoperineal (AP) pouch revision or pouch excision with conversion to a permanent end ileostomy or rarely Kock's continent ileostomy [11,12].

For patients requiring a definitive abdominopelvic procedure, the decision to attempt pouch revision, specifically a redo IPAA or neo-IPAA (Fig. 1, right panel), *vs* pouch excision can be difficult for physicians and patients alike. IPAA revisions are technically demanding procedures that require significant expertise, may necessitate referral to a specialty centre and may have long-term function consequences, while accepting an excision and permanent ileostomy can have a profound impact on the patient's perceived quality of life [13–18]. Currently, only data from single institution series performed in highly specialized centres are available to inform surgical decision-making surrounding these uncommon reoperative pouch procedures [11,16,19–26]. No multi-institutional data from a broad range of hospitals are available to inform surgeons and patients about what to expect in the perioperative period in terms of short-term surgical outcomes. Furthermore, when patients require a reoperative procedure due to pouch complications, few comparative data are available regarding the perioperative outcomes between pouch revision and pouch excision. The latter point is practically important as when a surgeon attempts a pouch revision it may not be technically possible and may result in pouch excision.

Therefore, we aimed to compare short-term (30-day) postoperative outcomes associated with pouch revision and with pouch excision using a large national database. Our null hypothesis was that there is no statistically significant difference in overall short-term postoperative complications between patients selected for pouch revision *vs* pouch excision.

Method

Data source and construction of cohort

The American College of Surgeons National Surgical Quality Improvement Program (NSQIP) is a multi-

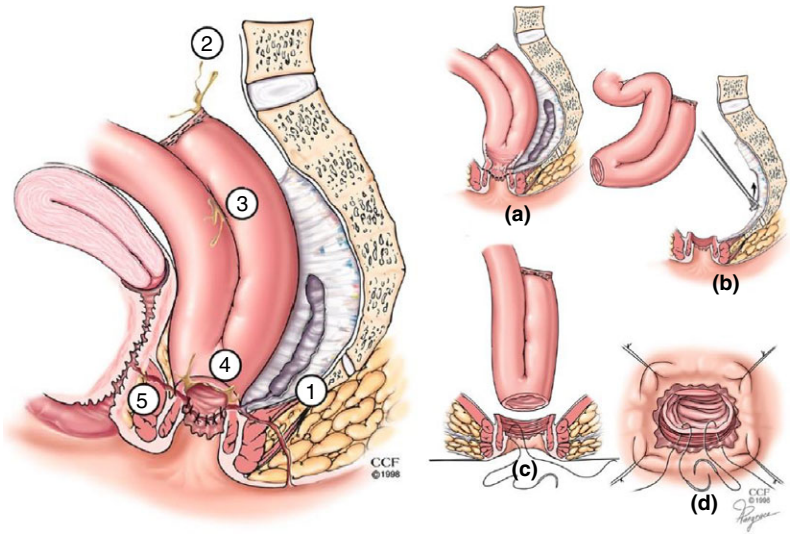

Figure 1 Illustration of common indications for pouch revision or excision (left panel) and illustration of an abdominoperineal redo pouch procedure as described by Victor Fazio MD (right panel). Left panel: 1, presacral sinus; 2, leak from tip of the J-pouch; 3, leak from body of the J-pouch; 4, pouch–anal anastomotic leak with transphincteric fistula-in-ano; 5, pouch–vaginal fistula. Right panel: (a) presacral sinus, (b) curettage of the presacral sinus, (c) and (d) hand-sewn re-anastomosis. ©CCF 2018. Used with permission of the Cleveland Clinic Foundation, Cleveland Clinic, Ohio, USA.

institutional, international registry of patients undergoing surgery within the 680 (as of 2016) participating hospitals. Participating hospitals pay a yearly subscription fee and employ surgical clinical reviewers (typically registered nurses) who collect data elements for 30 days after the index procedure. These include approximately 300 variables including demographics, comorbidities, preoperative laboratory values, operative details, including up to 10 'other' Current Procedural Terminology (CPT) codes by the same surgical team and 10 'concurrent' CPT codes by a different surgical team, and postoperative outcomes including complications stratified by organ system, length of stay, reoperation and readmission rates. Details of data abstraction methods and variable definitions are available on the NSQIP website (https://www.facs.org/quality-programs/acs-nsqip/participant-use). The anonymized dataset was then accessed via a Participant User File (PUF) [27].

Using the NSQIP PUF, we identified all patients who underwent surgery from 2005 to 2016. We then queried the resultant dataset for all patients who had a colorectal procedure using CPT codes 44000–46999. Finally, we constructed a retrospective cohort which included patients who underwent one of two major IPAA reoperative procedures: AP ileal pouch revision ('revision' group; CPT code 46712), i.e. pouch reconnection and re-anastomosis, and ileal pouch excision ('excision' group; CPT code 45136). One patient who had both CPT codes was excluded. Patients who underwent perineal only pouch advancement procedures (CPT code 46710) were not included in this study, nor were patients who underwent other types of pouch revisionary procedures which do not have a unique CPT code, such as the repair of a leak from the body or tip of the J not requiring disconnection and reconnection.

We report data on baseline preoperative characteristics, preoperative laboratory values, operative variables, 'other' and 'concurrent' procedures, and 30-day surgical outcomes. Our primary outcome was the short-term (30-day) overall composite complication rate. Secondary outcomes included total operative time in minutes, specific complications, length of stay, return to the operating room and 30-day mortality.

Statistical analysis

Potential differences between the two groups (revision *vs* excision), including preoperative characteristics, preoperative laboratory values and operative variables, were assessed with univariate analysis, specifically Student's *t* test or the Wilcoxon rank-sum test for continuous variables and the chi-squared test or Fisher's exact test for categorical variables as appropriate.

Given differences in baseline characteristics and to assess the robustness of our univariate analysis for differences in our outcome measures, two case-matched analyses were then conducted to evaluate outcomes after controlling for significantly different patient characteristics on univariate analysis (see below), excluding laboratory results as the observed differences in these values were not clinically significant, and excluding the difference in previous percutaneous coronary intervention because the amount of missing information resulted in an unacceptably low number of matches.

Revision cases were matched to excision cases based on gender, steroid use, transfusion status, preoperative wound or wound infection (i.e. fistulas), and hypertension medication status on a 1:1 basis. Matches for 76 (of the 78 revision patients) were found resulting in a total sample of 152 patients.

Finally, we compared our main outcome measures between the unmatched groups using Student's *t* test or the Wilcoxon rank-sum test for continuous variables and the chi-squared test or Fisher's exact test for categorical variables as appropriate. For the 1:1 matched analysis, case-matched logistic regression odds ratios or linear regression effect estimates (estimated difference between the two groups) are reported with 95% CI. For all analyses, probability values < 0.05 were considered significant. All analyses were carried out in JMP version 13 for Windows and Mac, and SAS version 9.4 for Windows (Cary, North Carolina, USA).

Ethical considerations

Our study was deemed exempt from institutional review board approval by the Cleveland Clinic Institutional Review Board.

Results

Over an 11-year period, 907 146 colorectal operations were performed. We identified a total of 593 pouch reoperative procedures: 78 (13%) patients in the revision group and 515 (86%) patients in the excision group. During this same time period, a total of 7988 IPAA procedures were performed (CPT codes 45113, 44158, 44211) for any diagnosis (proportionally 8.5% of that number of new IPAAs had an abdominopelvic revision or excision). Also during the same time period a total of 114 perineal pouch advancements and 176 continent ileostomies were performed. The relative proportion of revision *vs* excision was stable over the 12-year period (Fig. S1) with a mean of 7 and 43 revisions and excisions per year, respectively, in this sample.

Baseline patient characteristics are shown in Table 1. The groups did not differ with respect to age, race or body mass index (kg/m^2). However, the revision group had a greater proportion of women (65.4% *vs* 51.8%, $P = 0.02$), and fewer were receiving chronic steroids (3.9% *vs* 17.9%, $P = 0.0008$) relative to the excision group. The revision group was also more likely to have a preoperative wound or wound infection (14.1% *vs* 6.8%, $P = 0.02$) and to have received preoperative transfusions (5.1% *vs* 0.97%, $P = 0.02$) relative to the excision group. In terms of laboratory values, albumin did not differ significantly between groups. However, hematocrit and creatinine were significantly lower, and alkaline phosphatase

Table 1 Baseline characteristics in patients who underwent IPAA revision *vs* excision.

Characteristic	IPAA revision (%) (n = 78, 13%)	IPAA excision (%) (n = 515, 86%)	P value
Age, years	48.1 ± 16.8	47.1 ± 14.7	0.59
Women	51 (65.4)	267 (51.8)	0.03*
BMI, kg/m^2	25.2 ± 7.3	24.5 ± 6.0	0.41
Race			
White	57 (81.4)	371 (88.3)	0.55
Unknown	7 (10.0)	28 (6.7)	
Black or African American	4 (5.7)	13 (3.1)	
Asian	2 (2.9)	7 (1.7)	
American Indian	0 (0)	1 (0.24)	
Number of comorbidities	1.1 ± 1.2	0.84 ± 1.1	0.93
Independent functional status	76 (97.4)	505 (98.1)	0.69
Pack-years of smoking	12.2 ± 23.2	7.9 ± 21.6	0.31
Current smoker within 1 year	14 (17.9)	71 (13.8)	0.33
Ethanol > 2 drinks/day within 2 weeks	2 (5.7)	3 (1.2)	0.12
Steroids	3 (3.9)	92 (17.9)	0.002*
Weight loss	6 (7.7)	25 (4.9)	0.27
Preoperative open wound/wound infection	11 (14.1)	35 (6.8)	0.03*
Transfusion of > 4 PRBCs within 72 h	4 (5.1)	5 (0.97)	0.005*
Bleeding disorder	4 (5.1)	15 (2.9)	0.30
Diabetes mellitus, oral or insulin	6 (7.7)	30 (5.8)	0.52
Acute renal failure (pre-op)	–	3 (0.58)	0.99
History of severe COPD	1 (1.3)	6 (1.2)	0.93
Hypertension requiring medication	18 (23.1)	67 (13)	0.02*
Previous PCI	4 (11.4)	7 (2.8)	0.01†
Congestive heart failure within 30 days	–	2 (0.39)	0.99
History of angina within 1 month	1 (2.9)	1 (0.4)	0.23
History of revascularization /amputation	1 (2.9)	1 (0.4)	0.23
Disseminated cancer	3 (3.9)	6 (1.2)	0.10
Ascites	–	2 (0.39)	0.99
Chemotherapy within 30 days	–	4 (1.6)	0.99
Radiotherapy within 90 days	1 (2.9)	3 (1.2)	0.40
Preoperative sepsis	3 (3.8)	27 (5.2)	0.60
Systemic sepsis			
None	75 (96.2)	488 (94.8)	0.39
SIRS	1 (1.3)	18 (3.5)	
Sepsis	2 (2.6)	5 (0.97)	
Septic shock	–	4 (0.78)	

Figures represent mean ± standard deviation or frequency (proportion).

BMI, body mass index; COPD, chronic obstructive pulmonary disease; IPAA, ileal pouch–anal anastomosis; PCI, percutaneous coronary intervention; PRBCs, packed red blood cells; SIRS, systemic inflammatory response syndrome. No patients were on dialysis, had had a myocardial infarction within 6 months, or had rest pain/gangrene.

*Included in the matching algorithm.

†Not included in the matching algorithm due to missing data.

higher, in the revision group compared to the excision group, but these differences were not clinically significant.

Operative variables are summarized in Table 2. The two groups did not differ significantly with respect to the proportion of American Society of Anesthesiologists (ASA) class 3 or 4 patients, mean operative time, proportion of emergencies, proportion of patients with wound class 3 or 4 (contaminated, dirty or infected), or other procedures by the same surgical team (i.e. small bowel resection). However, revision patients were more likely to have 'concurrent' procedures by another surgical team (i.e. ureteral stents) during the same operation (83.3% *vs* 61.6%, $P = 0.0002$). Specific 'other' and 'concurrent' procedures for the entire retrospective cohort are shown in Table 3. Overall, secondary procedure codes were very common during pouch revision and excision. The most common concurrent procedure codes were adhesiolysis (23%), exploratory laparotomy (13.7%) and 'any' fistula take-down (7.3%); the most common 'other' procedures were cystoscopy with ureteral stents (44%), any hernia repair (6.6%) and any gynaecological procedure (3%).

In terms of postoperative diagnoses (Fig. S2), the most common indications in the pouch revision group were fistula, pouch–vaginal fistula and 'other', while the most common diagnoses in the excision group were 'other', Crohn's disease, UC, pouchitis and neoplasia.

Operative outcomes and 30-day postoperative outcomes

Overall, 34.6% and 40.2% ($P = 0.88$) of revision and excision patients, respectively, experienced postoperative complications. Postoperative outcomes are summarized in Table 4. We did not observe any significant difference in any postoperative outcomes between the two groups: 6.4% and 6.0% ($P = 0.89$) of patients required reoperation, postoperative length of stay was 9.3 *vs* 8.6 days ($P = 0.99$) and mortality was 0 *vs* 0.58% ($P = 0.99$) for the revision and excision groups, respectively.

The results of the revision to excision 1:1 matched analysis are also shown in Table 4. There was no statistically significant difference in complications between the two procedures.

Discussion

In this comparative analysis using a large international database we observed that, after accounting for differences in patient selection characteristics between patients who received pouch revision *vs* pouch excision, no statistically significant differences in early postoperative outcomes were observed between these groups. This modern, cross-sectional study is an important step in describing the current practice of IPAA reoperative procedures. In terms of reoperative techniques for IPAA, pouch excision is the most common procedure performed at an order of magnitude more frequently than pouch revision.

In this study, we report outcomes from a wide range of institutions across North America and select participating international centres. This provides a unique look at these procedures, as the vast majority, if not all, of the previously reported data on pouch revisions and excisions are from specialized units in North America and Europe, while the cases presented herein were performed at a variety of hospitals within the NSQIP.

Prior research has shown that UC patients with a change in diagnosis to Crohn's disease, preoperative steroid use, age < 50, severe proctitis and preoperative anaemia are reported to be at increased risk of pouch failure [28,29]. Ileoanal pouch reoperative surgery is

Table 2 Operative patient characteristics in patients who underwent IPAA revision *vs* excision.

Characteristic	IPAA revision (%) ($n = 78$, 13%)	IPAA excision (%) ($n = 515$, 86%)	*P* value
ASA classification 3 or 4	35 (44.9)	230 (44.7)	0.97
Emergency surgery	4 (5.1)	10 (1.9)	0.08
Wound class 3 or 4	36 (46)	190 (36.9)	0.12
Any other procedure	23 (29.5)	204 (39.6)	0.09
Any concurrent procedure	65 (83.3)	317 (61.6)	0.0002
No. of RBC units given intra-operatively	–	0.47 ± 1.1	0.06
Duration of anaesthesia	301.2 ± 113.3	331.3 ± 117.7	0.16
Operative time (min)	246.2 ± 120.8	260.5 ± 113.5	0.31

Figures represent mean ± standard deviation or frequency (proportion). ASA, American Society of Anesthesiologists; IPAA, ileal pouch–anal anastomosis; RBC, red blood cell.

Table 3 Other (by same surgical team) and concurrent (by different surgical team) procedures for the entire cohort of patients.

Other procedures	$N = 593$ (%)	Concurrent procedures	$N = 593$ (%)
Adhesiolysis	138 (23.3)	Cystoscopy/stents	262 (44.2)
Exploratory laparotomy	81 (13.7)	Hernia repair*	39 (6.6)
Fistula, any	43 (7.3)	Gynaecological procedure, any	18 (3.0)
Ileostomy	42 (7.1)	Other urological	11 (1.9)
Hernia repair†	38 (6.4)	Fistula repair, any	5 (0.8)
Small bowel resection and anastomosis	34 (5.7)	Bladder repair	4 (0.7)
Omental flap	28 (4.7)	Prostatectomy	4 (0.7)
Abscess drainage, any	26 (4.4)	Ureteral re-implantation	4 (0.7)
Ileostomy closure	24 (4.0)	Cholecystectomy	3 (0.5)
Endoscopy procedure, any	20 (3.4)	Exploratory laparotomy	3 (0.5)
Partial proctectomy	19 (3.2)	Urethral repair	2 (0.3)
Gynaecological procedure, any	15 (2.5)	Ileal conduit	1 (0.2)
Serosal tear or enterotomy repair	12 (2.0)	Other, NOS	7 (1.2)
Cholecystectomy	7 (1.2)		
Cystoscopy-stents	7 (1.2)		
Pelvic exclusion with mesh	6 (1.0)		
Liver biopsy	3 (0.5)		
Mesh excision	3 (0.5)		
Kock's pouch construction	2 (0.3)		
Other, NOS	87 (14.7)		

NOS, not otherwise specified. Figures represent frequency (proportion).
*Including mesh, flap, vacuum dressing placement, graft.
†Including mesh, flap, vacuum dressing placement.

technically demanding, especially pouch salvage procedures [11]. However, in a select group of patients, who are motivated to maintain intestinal continuity, revision procedures to salvage the failing pouch may be appropriate. The success rates of salvage procedures are reported to be 47%–84% [9].

Our data are similar to those of previous studies which also showed acceptable morbidity and low mortality with major pouch revision procedures. Overall, postoperative morbidity was < 40% and a reoperation rate of only 6% is well within the acceptable range for both pouch revision and pouch excision. Wound infection was the most common postoperative complication. Additionally, there is a 10% rate of postoperative transfusion for either group, probably due to increased bleeding from raw surfaces in the pelvis. The complexity of these operations is also reflected by the high proportion of 'other' and 'concurrent' procedures during the same operations, as well as the relatively high rate of postoperative sepsis (10%).

At present, surgeons performing reoperative ileal pouch procedures may look to multiple case series from highly specialized centres to inform their surgical decision-making (Table 5). These series primarily emphasize their overall salvage rate, with some reporting functional outcomes as well. Successful pouch salvage ranges from 47% to 84%, with good functional outcomes being somewhat lower (41%–64%). In contrast to our study, few authors report comprehensive perioperative outcomes from their reoperative experience. Shawki *et al.* [9] reported the average length of stay was 10.4 days in those undergoing a revision via an abdominal approach, which is similar to our cohort (12 days) [7]. Similarly, Remzi, Tsujinaka and colleagues [18] reported an operative mortality rate of 0.8%, as in this study which too had a 0% mortality in the 78 revision patients.

Our study has several important limitations. First, because only centres contributing data to the NSQIP are included, our data are not population based. The denominator to calculate the revision rate is a rough estimate. Centres participating in the NSQIP do so on a voluntary self-selected basis and many of the procedures were performed at referral centres. These results may not therefore be applicable to all centres. Secondly, selection bias is a known limitation, as choice of surgical approach is based on individual patient and surgeon decision-making and is likely to reflect the complex interaction of individual patient health and functional status, disease pathology, and surgeon training and experience; however, our matched analyses account for observed differences in baseline characteristics. Thirdly, several authors report that patients undergoing revision procedures often require multiple

Table 4 Thirty-day surgical outcomes and morbidity in patients who underwent IPAA revision *vs* excision.

Postoperative outcomes	IPAA revision (%) (n = 78, 13%)	IPAA excision (%) (n = 515, 86%)	Univariate P value	Case matched (76:76) analysis	
				Odds ratio (95% CI)	P value
Length of total hospital stay, days	10.4 ± 11.9	9.9 ± 10.4	0.64	−1.3 (−6.0, 3.3)*	0.58
Postoperative length of stay, days	9.3 ± 10.6	8.6 ± 6.4	0.44	0.02 (−3.0, 3.1)*	0.99
Any postoperative complication	27 (34.6)	207 (40.2)	0.88	0.68 (0.37, 1.3)	0.22
Specific complications					
Any wound complication	14 (17.9)	119 (23.1)	0.31	0.59 (0.27, 1.3)	0.18
Superficial SSI	5 (6.4)	51 (9.9)	0.33	0.80 (0.21, 3.0)	0.74
Deep incisional SSI	1 (1.3)	19 (3.7)	0.27	0.20 (0.02, 1.7)	0.14
Organ space SSI	7 (9.0)	57 (11.1)	0.58	0.67 (0.24, 1.9)	0.44
Wound dehiscence	**5 (6.4)**	**6 (1.2)**	**0.001**	**0.80 (0.21, 3.0)**	**0.74**
Pneumonia	2 (2.6)	13 (2.5)	0.98	0.33 (0.03, 3.2)	0.34
Unplanned intubation	2 (2.6)	6 (1.2)	0.32	2.0 (0.18, 22.1)	0.57
On ventilator > 48 h	1 (1.3)	5 (0.97)	0.80	1.00 (0.06, 16.0)	0.99
Acute renal failure	–	2 (0.39)	0.99	2.0 (0.18, 22.1)	0.57
Progressive renal insufficiency	2 (2.6)	3 (0.58)	0.13	2.0 (0.18, 22.1)	0.57
Urinary tract infection	4 (5.1)	24 (4.7)	0.86	1.00 (0.25, 4.0)	0.99
DVT/thrombophlebitis	–	4 (0.78)	0.99	0.89 (0.34, 2.3)	0.81
Pulmonary embolism	–	4 (0.78)	0.99	2.0 (0.18, 22.1)	0.57
CVA/stroke	–	–	–	1.00 (0.25, 4.0)	0.99
Coma > 24 h	–	–	–	1.00 (0.25, 4.0)	0.99
Cardiac arrest requiring CPR	–	3 (0.58)	0.99	1.00 (0.25, 4.0)	0.99
Myocardial infarction	1 (1.3)	–	0.13	1.00 (0.25, 4.0)	0.99
Transfusions (intra-operative or postoperative)	10 (12.8)	70 (13.6)	0.85	0.89 (0.34, 2.3)	0.81
Sepsis	6 (7.7)	49 (9.5)	0.61	1.00 (0.29, 3.5)	0.99
Readmission	8 (10.3)	44 (8.4)	0.67	1.00 (0.29, 3.5)	0.99
Return to the operating room	5 (6.4)	31 (6)	0.89	0.80 (0.21, 3.0)	0.74
Death within 30 days of surgery	–	3 (0.58)	0.99	0.80 (0.21, 3.0)	0.74

Figures represent mean ± standard deviation or frequency (proportion). Cases were matched based on gender, steroid use, transfusion, preoperative wound infections and hypertension. CPR, cardiopulmonary resuscitation; CVA, cerebrovascular accident; DVT, deep vein thrombosis; IPAA, ileal pouch–anal anastomosis; SSI, surgical site infection.
*Effect size, not odds ratio.

operations; we were unable to account for patients who received a staged approach with a diverting loop ileostomy for their failing pouch, and we felt that perineal only procedures were inherently different to major pouch revision or AP excision. Thus our study, as stated above, does not give a comprehensive view of all the available options for the failing pouch; rather our study aimed only to assess the differences in outcomes between AP revision and excision. Finally, due to the inherent limitations of the NSQIP, no long-term functional outcomes or complications are reported and no information regarding the duration of time from pouch construction, nor pouch confirmations (e.g. J- *vs* S-pouch) or anastomotic techniques (i.e. stapled *vs* hand-sewn) are available. In terms of the former limitation, it is important to emphasize that sub-optimal long-term functional outcomes and late complication after pouch revision can lead to secondary failure (of the revised pouch), and must be taken into consideration when counselling patients [18,25]. Despite these limitations, this study provides unique insight into outcomes after major reoperative surgery for ileal pouches from a large national clinical database.

In summary, we found that pouch revision and excision procedures have acceptable operative morbidity and low operative mortality within NSQIP hospitals. These data can help inform patients, surgeons and gastroenterologists when counselling patients on the reoperative pouch procedure to address major ileal pouch-related complications. Our findings also suggest that, since excision is almost an order of magnitude more common, revisions may be performed less commonly and colorectal surgeons should consider revision as a viable option or consider referral to a specialty referral centre when faced with a failing pouch.

Table 5 Results of ileoanal pouch salvage surgery.

First author	Year	City, state/country	*N*	Overall complication rate, %	Salvage rate, %	Functional outcome, %	Functional outcome definition
Galandiuk [19]	1990	Rochester, MN, USA	114		80	70	Excellent functional outcome
Sagar [20]	1996	Rochester, MN, USA	23	–	74	–	
Ogunbiyi [21]	1997	Birmingham, UK	32	–	50	–	
Fazio [22]	1998	Cleveland, OH, USA	35	34.3	86	57	Quality of life good or excellent
Cohen [23]	1998	Toronto, Canada	24	–	75	72	Normal daytime continence
Fonkalsrud [24]	1999	Los Angeles, CA, USA	164	11.6	93	90	< 1 staining episode/week
Dayton [16]	2000	Salt Lake City, UT, USA	16	37	100	44	Incontinence never or rarely
Zmora [11]	2001	Fort Lauderdale, FL, USA	32	–	84	64	< 12 bowel motions per day, good control, patient satisfaction
MacLean [30]	2002	Toronto, Canada	57	51	74	89	Less than 10 bowel motions per day
Gorfine [28]	2003	New York, NY, USA	51	–	66.7	86	Perfect or near perfect continence
Baixauli [13]	2004	Cleveland, OH, USA	101	–	74	50	Faecal seepage
Dehni [33]	2005	Paris, France	64	13	94	50	Faecal incontinence
Tekkis [31]	2006	London, UK	112	–	79	–	
Mathis [32]	2009	Rochester, MN, USA	51	24	89	39	Faecal incontinence
Remzi [34]	2009	Cleveland, OH, USA	241	–	88	63	Rarely/no faecal incontinence
Shawki [9]	2009	Weston, FL, USA	68	–	56	–	
Remzi [18]	2015	Cleveland, OH, USA	502 (redo only)	53	80	50	Faecal seepage
Aydinli [35]	2017	Cleveland, OH, USA	5 (H-pouches only)	40	80	–	
Lightner [25]	2018	Rochester, MN	81 (redo's only)		77%; 10-year pouch survival 65%		Significantly more daytime bowel incontinence, liquid stool, and stool thickening medications compared to primary IPAA patients
Present study	2018	NSQIP	593	39.3	13.2*	–	

*A relative, not actual, revision rate; the relative revision rate was 32.4% including 114 perineal pouch advancement cases from the same time period which will be reported separately in the near future.

Acknowledgements

The authors would like to acknowledge Dr Andrea Stroud for her contributions to the original poster and an early draft of this paper with < 50% as many patients. The authors would also like to thank Cleveland Clinic Lerner College of Medicine Librarian Ms Cynthia Avallone for her help in the literature search. We would also

like to thank Joseph Pangrace CMI, Center for Medical Art and Photography, Cleveland Clinic, for providing the artwork.

Conflicts of interest

None declared.

Source of funding

None declared.

Author contributions

All authors have given substantial contributions to the conception, design, analysis and interpretation of data for the work. All authors have also contributed to drafting the work. All authors have given final approval of the version to be published. All authors are in agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Fig. S1. Relative proportion of revision *vs* excision over time.

Fig. S2. Indications for pouch revision and excision.