Early and late surgical outcomes of ileal pouch-anal anastomosis within a defined population in Sweden

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Objective Ileal pouch-anal anastomosis (IPAA), has become the procedure of choice in patients requiring reconstructive surgery for ulcerative colitis or familial adenomatous polyposis. The aim of this population-based study was to present data prospectively registered and retrospectively evaluated on the short-term and the long-term results of 124 consecutive IPAA performed chronologically by three surgeons in a single referral centre.

Materials and methods All patients who underwent IPAA from 1993 to 2012 were included. Early and late morbidity and mortality were evaluated.

Results Early complications were observed in 25 patients. There was one death from cardiac failure, high output stoma occurred in six patients and wound infection occurred in four patients. Complications were associated with higher BMI ($P = 0.032$). Four patients had to be reoperated. Peroperative bleeding was reduced when using an ultrasonically activated scalpel for the perimuscular dissection ($P < 0.00001$). Clavien–Dindo grade III–V affected five patients. Only one patient developed anastomotic leak and septic complications. Late complications occurred in 61 patients. There was no procedure-related mortality. Pouchitis was the most common complication ($n = 37$). Primary sclerosing cholangitis and age younger than 40 years were associated significantly with a three- and two-fold increased risk of pouchitis, respectively. Small bowel obstruction was the second most common complication ($n = 16$), more common in women ($P = 0.031$). The pouch failure rate was low: 2.4%. Clavien–Dindo grade III–V affected 13 patients.

Conclusion In the hands of experienced high-volume surgeons, IPAA is a safe procedure associated with a relatively low early morbidity as well as an acceptable late morbidity. Eur J Gastroenterol Hepatol 28:842–849

Introduction

Ileal pouch-anal anastomosis (IPAA), first described in 1978 [1], has become the procedure of choice in patients requiring reconstructive surgery for ulcerative colitis (UC) or familial adenomatous polyposis (FAP) [2,3]. The rate of surgical complications varies in the literature [2,4–9].

The aim of this population-based study was to present data prospectively registered and retrospectively evaluated on the short-term and long-term results of 124 consecutive IPAA performed chronologically by three surgeons in a single referral centre. Our setting is of interest because it assesses the outcome of IPAA within a defined population.

Materials and methods

Patients

Eskilstuna County Hospital is a referral centre for patients requiring restorative proctocolectomy with IPAA in the county of Södermanland in central Sweden (population 272 000 in 2011). During the 20-year study period 1993–2012, one county hospital and two district hospitals were operative. All restorative proctocolectomies were performed at Eskilstuna County Hospital. With the exception of two patients referred outside the county for individual reasons, the study was carried out in a completely population-based setting.

The first 124 consecutive patients at our institution, 71 men and 53 women, undergoing restorative proctocolectomy with an IPAA up to 2012 were assessed. The indications for surgery were UC ($n = 110$), UC and colorectal cancer ($n = 2$), colorectal cancer ($n = 6$), FAP ($n = 4$), FAP and colorectal cancer ($n = 1$) and hereditary colorectal cancer ($n = 1$). Of the 124 IPAA, proctocolectomy was synchronously performed in 31 cases and in 93 cases, completion with proctectomy was performed after initial colectomy. During the study period, around 2.3 IPAA per 100 000 population were performed yearly. Data prospectively recorded in our IPAA database included patient demographics, surgical procedures and indications for surgery, type and duration of diseases, previous operations, pathology of the resected specimens, early (in-hospital or within 30 days after surgery) and late complications (including those after loop ileostomy closure), length of stay after surgery, functional results, postoperative pathology and follow-up.

None of the patients had received biologic drugs 6 months before IPAA. Only three patients were on azathioprine and only one patient was taking methotrexate. The drugs were discontinued 3 weeks before IPAA. Just

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Keywords: complications, ileal pouch-anal anastomosis, outcome, pouchitis, primary sclerosing cholangitis, surgery, ulcerative colitis

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five patients were on prednisolone, which was reduced gradually to be discontinued the week before surgery.

The median age of the patients was 44 (range 15–73) years: 47 (range 18–73) years among males and 43 (range 15–66) years among females, respectively. Patient characteristics and operative factors are presented in Table 1.

All complications, both pouch-related as well as non-pouch-related complications, were recorded. In addition, all complications were reclassified retrospectively according to the Clavien–Dindo system of classification proposed in 2004 [10].

Our colorectal unit has a close collaboration with gastroenterologists, histopathologists and gastrointestinal radiologists. The multidisciplinary approach also includes enterostomal specialist nurses, dieticians and surgical ward nurses with extensive experience with patients undergoing major colorectal surgery.

The study was approved by the Regional Ethical Review Board.

Surgical technique

All restorative proctocolectomies with IPAA were performed by three surgeons. During the study period, these three surgeons chronologically carried out 14, 31 and 79 procedures, respectively. Thus, only one surgeon performed all restorative proctocolectomies during each part of the study period. The two surgeons performing 14 and 31 procedures had extensive previous experience of restorative proctocolectomy and IPAA.

The colonic mesentery was divided close to the bowel wall, except in patients with cancer or in patients with polyps with high-grade dysplasia. The terminal ileum was transected flush to the ileocaecal valve, with preservation of the ileocolic artery both in colectomies and in synchronous proctocolectomies. The proctectomy was performed in noncancer cases using a perimuscular dissection preserving the superior rectal artery and also preserving the mesorectal fat. The perimuscular dissection was performed using electrocoagulation during the first 10 years of the study period. The technique was then changed to use of an ultrasonically activated scalpel (Harmonic Scalpel; Ethicon Endo-Surgery Inc., Cincinnati, Ohio, USA). In patients with rectal cancer, total mesorectal excision (TME) was performed [11].

A K-pouch with transanal mucosectomy and a hand-sewn IPAA was used during the first 3 years of the study period. We then chose to change the technique to the technically more straightforward stapled J-pouch [12,13] using linear staplers with a stapled anastomosis using a linear stapler and a 29 mm circular stapler.

Before transection of the rectum, a rigid rectoscopy was performed to assess the distance to the dentate line and ascertain a rectal remnant of no more than 5–10 mm. The integrity of the IPAA was tested by air insufflation in the pouch using a 28 Ch Foley catheter (Teleflex Medical Europe Ltd, Athlone, Co. Westmeath, Ireland) inserted transanally after the pelvis had been filled with saline.

A 12 Ch suprapubic catheter was routinely installed into the bladder to reduce pain and the risk of recatheterization [14]. The pelvis was drained with one or two

Table 1. Patient characteristics and operative factors

Sex [*n* (%)]	
Male	71 (57.3)
Female	53 (42.7)
Age (years)	
Mean (SD)	42.3 (14.9)
Median (IQR)	44 (28.5–55)
BMI (kg/m^2)	
Mean (SD)	24.8 (4.2)
Median (IQR)	24.5 (21.5–27.5)
ASA fitness score	
Mean (SD)	1.4 (0.5)
Median (IQR)	1 (1–2)
Smokers [*n* (%)]	
Yes	11 (8.9)
No	108 (87.1)
Unknown	5 (4.0)
Primary sclerosing cholangitis [*n* (%)]	
Yes	4 (3.2)
No	120 (96.8)
Comorbidity [*n* (%)]	
No	86 (69.4)
Cardiovascular	18 (14.5)
Diabetes	5 (4.0)
Pulmonary	5 (4.0)
Others	16 (12.9)
Age at onset of UC (years) (*N* = 112)	
Mean (SD)	31.8 (13.8)
Median (IQR)	28 (21–42)
Duration of UC before surgery (years) (*N* = 112)	
Mean (SD)	8.9 (9.4)
Median (IQR)	5 (2–12)
Follow-up after IPAA (years)	
Mean (SD)	11.1 (5.5)
Median (IQR)	11.2 (6.2–15.8)
Colectomy synchronously [*n* (%)]	
Yes	31 (25)
No	93 (75)
Diverting loop ileostomy [*n* (%)]	
Yes	123 (99.2)
No	1 (0.8)
Distance loop ileostomy-pouch (cm)	
Mean (SD)	39.4 (19.8)
Median (IQR)	35 (25–50)
Reservoir type [*n* (%)]	
K	13 (10.5)
J	111 (89.5)
Pouch-anal anastomosis [*n* (%)]	
Hand-sewn	9 (7.3)
Stapled	115 (92.7)
Dissection [*n* (%)]	
Perimuscular	105 (84.7)
TME	19 (15.3)
Peroperative bleeding (ml)	
Mean (SD)	466.8 (485.1)
Median (IQR)	325 (100–650)
Harmonic scalpel [*N* (median)]	49 (100)
Electrocoagulation [*N* (median)]	56 (500)
TME [*N* (median)]	19 (1000)
Operating time (min)	
Mean (SD)	353.3 (110.6)
Median (IQR)	327 (280–396.5)
Harmonic scalpel [*N* (median)]	49 (315)
Electrocoagulation [*N* (median)]	56 (321)
TME [*N* (median)]	19 (457)
Time to loop closure (days) (*N* = 122)	
Mean (SD)	238.1 (264.7)
Median (IQR)	176 (126–244)
LoS IPAA (days)	
Mean (SD)	10.2 (5.3)
Median (IQR)	8 (7–11)
LoS loop closure (days) (*N* = 122)	
Mean (SD)	5.8 (9.6)
Median (IQR)	4 (3–5)

Figures are numbers unless otherwise specified.
ASA, American Society of Anesthesiologists; IPAA, ileal pouch-anal anastomosis; IQR, interquartile range; TME, total mesorectal excision; UC, ulcerative colitis.

drains for 2–3 days and the pouch was drained using a 28 Ch Foley catheter inserted through the anus for 5 days. A diverting loop ileostomy, as close to the pouch as possible, was used in all except one of the procedures.

With the exception of the first 3 years of the study period, the loop ileostomy was not rotated; thus, the proximal limb was positioned cranial to the distal limb.

Before ileostomy closure, the integrity of the IPAA was evaluated by clinical investigation, endoscopic examination and water-soluble contrast enema.

Follow-up

All patients undergoing restorative proctocolectomy with IPAA were followed up at the Colorectal Unit, Eskilstuna County Hospital. Annual random routine biopsies of the pouch and anal transitional zone were performed in all patients with dysplasia (or cancer) in the colectomy or proctectomy specimens. Furthermore, biopsies were taken from any abnormal findings. Endoscopy of the reservoir with biopsies was also performed when there was a clinical suspicion of pouchitis. The criteria for a diagnosis of pouchitis were a combined assessment of symptoms (increased stool frequency, urgency and tenesmus) and signs of inflammation at pouch endoscopy and in the histopathology specimens.

Statistical analysis

The data were prospectively recorded. Continuous variables were compared using the Mann–Whitney *U*-test; for discrete categorical data, Fisher's exact test was used to test 2×2 contingency table data. Results are expressed as two-tailed levels of probability.

The analysis of time to pouchitis was carried out by Cox regression and precolectomy appendectomy, sex, age (≤ 40 years, > 40 years, i.e. median), duration of UC (≤ 5 years, > 5 years, i.e. median), primary sclerosing cholangitis (PSC) and smoking were considered predictors. First, each factor was analysed in a univariate model and then all variables were included in a multivariate model to investigate whether the univariate results were confounded by other variables. Results are presented as hazard ratios together with 95% confidence intervals and a Wald's test was used to assess the statistical significance for each predictor.

Pouch success was defined as no pouch excision or no indefinite diversion during the study period. Consequently, pouch failure was defined as necessity to perform pouch excision or indefinite diversion. The pouch failure rate was defined as the number of pouches excised or diverted divided by the total number of pouches performed during the study period. Remaining free from pouchitis was defined as no diagnosis of pouchitis during the study period. The cumulative probability of pouch success and the cumulative probability of remaining free from pouchitis were estimated by Kaplan–Meier analyses. The data for the Kaplan–Meier analyses were retrieved from the prospectively recorded data of pouch-related complications in our IPAA database. *P* value less than 0.05 was considered to be significant.

Results

Early morbidity

The transition from using electrocoagulation to an ultrasonically activated scalpel for perimuscular dissection facilitated the perimuscular dissection and thereby significantly reduced the peroperative bleeding ($P < 0.00001$) (Table 1).

Postoperatively, all patients were treated in the colorectal surgical ward before discharge from the hospital. No patient had to be admitted to the ICU. In 99 patients (79.8%), the postoperative course was uneventful. In the remaining 25 patients (20.2%), there were complications. These complications are listed in Table 2. One patient (0.81%) died of cardiac failure on the eighth postoperative day. There were relatively more complications in male patients (23.9%) than in female patients (15.1%), but the difference did not reach statistical significance ($P = 0.26$). Patients with complications had a higher median BMI (27.0) than patients without complications (median BMI 23.8). The difference was statistically significant ($P = 0.032$). One of the patients with abdominal wound dehiscence had had azathioprine discontinued 3 weeks before IPAA. Only four patients had to be reoperated (3.2%). In one patient, primary anastomosis was not possible after construction of the pouch because the mesentery was too short. The opening of the pouch was left as an ileostomy and the IPAA was completed 3 months later uneventfully. According to the Clavien–Dindo classification, five patients (4.0%) had complications graded as severe (Clavien–Dindo grade III–V).

Late morbidity

In 61 patients (49.2%), there were late complications, presented in Table 3. However, there was no procedure-related late mortality.

Two patients had to have their pouches removed after 832 days and 1121 days, respectively, because of poor pouch function. Both were men in their 70s who had undergone short-course preoperative radiotherapy (5×5 Gy) and TME surgery for rectal cancer. The third patient with poor pouch function was diverted with a loop ileostomy after 1288 days and chose to have no further surgery. The cumulative probability of pouch success over time is shown in Fig. 1.

Small bowel obstruction (SBO), was the second most frequent late complication in our study, more common in female (20.8%) than in male patients (7.0%), $P = 0.031$. Surgical intervention was necessary in six patients (37%) and in 10 patients (63%), the obstruction was resolved conservatively.

The most frequent late morbidity was pouchitis. In all pouchitis patients, the indication for surgery had been UC. In both female and male pouchitis patients, 5% were smokers.

The presence of PSC and age younger than 40 years were significantly associated with a three- and two-fold increased risk of pouchitis, respectively.

Comparisons of demographic and clinical data between UC patients with and without pouchitis are described in detail in Table 4.

Table 2. Early morbidity and mortality in 124 patients undergoing restorative proctocolectomy and IPAA

Complication	*N* (%)	Clavien–Dindo grade	Sex (male : female)	Number of patients requiring reoperation
Bleeding from the pouch	3 (2.4)	II (*N* = 2), IIIb (*N* = 1)	3 : 0	1
Intra-abdominal bleeding	3 (2.4)	II	2 : 1	0
Anastomotic leak	1 (0.81)	IIIa	0 : 1	0
Primary anastomosis not possible	1 (0.81)	IIIb	1 : 0	1[a]
Abdominal wound dehiscence	2 (1.6)	IIIb	2 : 0	2
Wound infection	4 (3.2)	I	1 : 3	0
High-output stoma	6 (4.8)	I	4 : 2	0
Bilateral paralysis of the peroneal nerves	1 (0.81)	I	1 : 0	0
Pancreatitis	1 (0.81)	II	1 : 0	0
Fungal sepsis	1 (0.81)	II	1 : 0	0
Atrial fibrillation	1 (0.81)	I	0 : 1	0
Cardiac failure and subsequent death	1 (0.81)	V	1 : 0	0
Total number of patients with complications	25 (20.2)	I–II (*N* = 20), III–V (*N* = 5)	17 : 8	4

Figures are numbers with percentages in parentheses.
IPAA, ileal pouch-anal anastomosis.
[a]The ileoanal anastomosis was completed 3 months later.

Table 3. Late morbidity and mortality in 124 patients undergoing restorative proctocolectomy and IPAA

Complications	*N* (%)	Clavien–Dindo grade	Sex (male : female)	Interval from IPAA (years)	Treatment
Pouch failure	3 (2.4)	IIIb	3 : 0	2.3 (3.1)	Pouch removal (*n* = 2)
		IIIb		3.5	New loop ileostomy (*n* = 1)
Pouch/anastomotic-cutaneous fistula	1 (0.81)	IIIb	0 : 1	9.6	Seton
Small bowel obstruction	16 (12.9)	I (*N* = 10), IIIb (*N* = 6)	5 : 11	3.2 (1.9–4.0)[a]	Surgical intervention (*n* = 6)
				3.7 (0.4–9.6)[b]	Conservative (*n* = 10)
Incisional hernia	1 (0.81)	IIIb	0 : 1	1.8	Hernia repair
Pouchitis (in UC patients, *N* = 112)	37 (33.0)	II	18 : 19	3.5 (1.4–7.2)[b]	Antibiotic/steroid therapy
IPAA stricture, hand-sewn anastomosis	1 (0.81)	IIIa	1 : 0	9.8	Endoscopic dilatation
Leak after loop ileostomy closure	2 (1.6)	I (*N* = 1), IIIa (*N* = 1)	1 : 1	–	Conservative (*n* = 1)
				–	Drainage (*n* = 1)
Total number of patients with complications	61 (49.2)	I–II (*N* = 48), III–V (*N* = 13)	28 : 33		

Figures are numbers with percentages in parentheses.
IPAA, ileal pouch-anal anastomosis; UC, ulcerative colitis.
[a]Median (IQR).
[b]First episode, median (IQR).

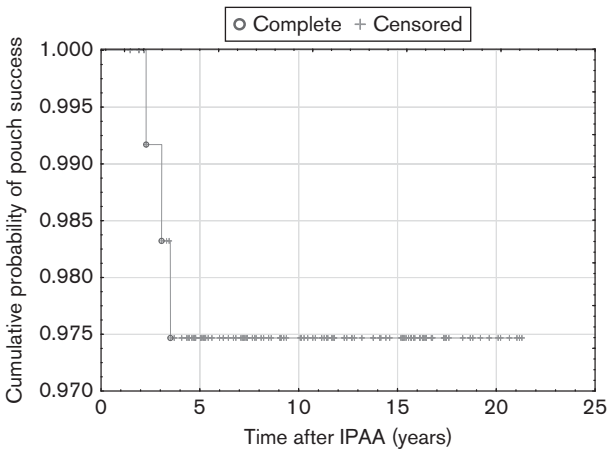

Fig. 1. Pouch success. The figure shows the cumulative probability of pouch success over time. IPAA, ileal pouch-anal anastomosis.

The cumulative probability of remaining free from pouchitis over time after closure of the loop ileostomy is presented in Fig. 2.

There were two leaks after closure of the loop ileostomy. One leak was managed conservatively; the other leak occurred in a patient in whom the closure had been performed at another hospital in the county. It was handled by drainage. Using the Clavien–Dindo classification, 13 patients (10.5%) had complications graded as severe.

Discussion

We have found a low mortality rate and a relatively low early morbidity as well as an acceptable late morbidity in patients undergoing restorative proctocolectomy and IPAA.

Our centre is categorized as medium volume according to two population-based studies assessing outcomes in relation to hospital volume [4,8]. Our surgeon volume, however, is categorized as high volume [8]. It is essential that the colorectal surgeon is very experienced in IBD surgery in addition to pelvic surgery and a high-volume provider of rectal cancer. A recent Cochrane review concluded that the volume–outcome relationship appears to be somewhat stronger for the individual surgeon than for the hospital after colorectal cancer surgery [15]. It is reasonable to assume the same volume–outcome relationship for IBD surgery.

Another prerequisite is that the colorectal surgeon as well as the rest of the team are dedicated to the task. A multidisciplinary approach is necessary involving close collaboration with gastroenterologists and support of experienced gastrointestinal radiologists and histopathologists [8,16]. A further requirement is enterostomal specialist nurses, dieticians and a surgical ward with nurses with extensive experience of patients undergoing major colorectal surgery. Of vital importance is also a continuous prospective monitoring to evaluate and improve the

Table 4. Cox regression analysis of risk factors for pouchitis in UC patients

Variable	Value	*N*	Pouchitis	Person years	Rate (per 100 person years)	Hazard ratio (crude)	95% CI	*P* value (crude)	Hazard ratio (adjusted)	95% CI	*P* value (adjusted)
Sex	Female	50	19	446.9	4.3	1.00	Reference	–	1.00	Reference	–
	Male	62	18	566.3	3.2	0.73	0.38–1.40	0.348	0.65	0.33–1.27	0.209
Age	> 40 years	56	12	552.2	2.2	1.00	Reference	–	1.00	Reference	–
	≤ 40 years	56	25	461.0	5.4	2.41	1.21–4.80	0.012	2.37	1.15–4.90	0.020
Duration of UC	> 5 years	54	16	499.9	3.2	1.00	Reference	–	1.00	Reference	–
	≤ 5 years	58	21	513.4	4.1	1.21	0.63–2.31	0.573	0.98	0.49–1.97	0.965
Primary sclerosing cholangitis	No	108	34	992.1	3.4	1.00	Reference	–	1.00	Reference	–
	Yes	4	3	21.2	14.2	3.40	1.03–11.2	0.045	3.68	1.08–12.5	0.037
Smoker	No	104	36	933.9	3.9	1.00	Reference	–	1.00	Reference	–
	Yes	8	1	79.4	1.3	0.34	0.05–2.47	0.286	0.47	0.06–3.64	0.470
Precolectomy appendectomy	No	75	30	716.3	4.2	1.00	Reference	–	1.00	Reference	–
	Yes	37	7	297.0	2.4	0.53	0.23–1.22	0.136	0.57	0.24–1.35	0.201

CI, confidence interval; UC, ulcerative colitis.

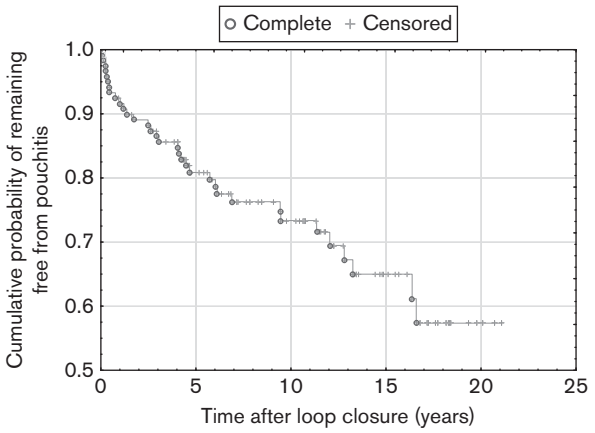

Fig. 2. Pouchitis. The figure shows the cumulative probability of remaining free from pouchitis over time.

performance of the pouch surgery. Research in pouch surgery would benefit from implementing a nationwide IPAA registry in the future.

The strength of this study is that it is population based. All operations were performed in a single hospital with a defined catchment area, the entire county. An advantage with a population-based setting is that it almost excludes the risk of sampling bias and/or selection bias. Second, data were prospectively recorded. Another advantage is that adverse events were treated within the county and registered in the data records shared by all three hospitals in the county. Thus, all adverse events were included in our study, resulting in a complete follow-up with no risk of underestimation of the rate of adverse events. In addition, the mean follow-up duration in this study is over 11 years.

A weakness of the present study is the relatively small cohort size. This limits the ability to show statistical significance, if any. A large cohort size enables detailed analyses [2].

However, the problems with a small cohort size can be overcome in the future by implementing a nationwide IPAA registry in analogy with the Swedish Rectal Cancer Registry, implemented successfully in 1995 [17]. In 2012, the Swedish Rectal Cancer Registry comprised 30 000 patients including greater than 98% of all rectal cancer patients.

The rate of IPAA in our setting, 2.3 per 100 000 population yearly, was almost identical to that reported by Kennedy *et al.* [4] from Canada (2 per 100 000 population yearly). Also, the reported incidence of UC in Canada (19.2 per 100 000 population) and the incidence in Sweden (17.5 per 100 000 population) were comparable [18].

The low morbidity rate was in agreement with earlier studies. [2,8,19] The overall early morbidity of 20% was in line with several previously presented studies [5,20], but lower than that reported in other studies [2,6,21].

We found that transition from using traditional electrocoagulation to an ultrasonically activated scalpel for perimuscular dissection facilitated the perimuscular dissection and thereby significantly reduced the peroperative bleeding ($P < 0.00001$) (Table 1). Although a comparison was made between two consecutive periods of time, the benefit of using an ultrasonically activated scalpel for this part of the procedure has not been described previously.

The low rate of septic complications in our study, only 0.81% compared with a previously reported range of 5–22% [2,5,22–25], may be explained by the use of a diverting loop ileostomy in 123 of 124 patients [22,26].

However, the incidence is not affected, only the clinical consequences of a leakage [27]. Theoretically, subclinical leakages without any sign of pelvic sepsis may have been undetected irrespective of the careful prospective recording of data.

Another explanation may be that we were very careful with drugs that could affect morbidity. Steroids, immunosuppressive drugs and biologic drugs were discontinued before IPAA in all patients. Several studies have shown an association between these drugs and increased septic complications [26,28–30]. However, there are also studies showing no association with increased septic complications in patients on systemic steroid therapy and immunosuppressive drugs before surgery [31,32].

Third, the drainage of the pouch using a 28 Ch Foley catheter inserted through the anus may have also played a role in the low rate of septic complications [33].

Like some authors, we found a correlation between high BMI and complications, [34,35], although not confirmed by others [36].

The possibility of detecting late morbidity increases with longer follow-up [2,13,21]. Thus, a long follow-up is necessary not to underestimate the rate of late morbidity. In this context, the over 11-year follow-up in the present study is comparatively long and the overall late morbidity of 49.2% is in agreement with previously presented data showing late morbidity of 27–50% [2,13,21].

The low rate of IPAA stricture in our study, only 0.81% (one patient with hand-sewn anastomosis), is difficult to explain.

An explanation may be that we have managed to avoid high mesenteric tension. High mesenteric tension after IPAA has been shown to be associated adversely with an anastomotic stricture [37].

Another explanation may be that we used a 29 mm circular stapler in all patients with a stapled IPAA. Lewis *et al.* [38] showed that a factor that significantly predisposed towards the development of an ileoanal anastomotic stricture was the use of a 25 mm (small) circular stapler. Most papers do not report the size of the circular stapler [2,39–41]. However, there are also papers showing no statistical difference in the incidence of stenosis according to the size of the staple head [34,42].

The type of pouch is also associated with development of an anastomotic stricture. According to a paper by Lewis *et al.* [38] W reservoirs are more likely to be affected by stricture than J reservoirs. In 111 of 124 patients, we used a J reservoir and in 13 patients, we used a K reservoir. The association between W reservoir and development of an anastomotic stricture is contradicted by Senapati *et al.* [42]. In 162 of 266 IPAA, a W reservoir was performed, but there was a significantly lower incidence of stenosis in those patients who had a W-pouch compared with those who had a J-pouch or a K-pouch.

Our low rate of anastomotic dehiscence, only one patient, may have also contributed towards the low rate of IPAA stricture in our study. Anastomotic dehiscence and pelvic sepsis are risk factors for the development of an anastomotic stricture [38,40].

In a large meta-analysis by Lovegrove *et al.* [39] the rate of strictures was 18% in hand-sewn anastomoses (mean follow-up 1.6 years) and 12% in stapled (mean follow-up 2.2 years).

In 1884 IPAA constructed at the Mayo Clinic in Rochester, Minnesota, strictures occurred in 213 patients. A greater number of strictures were observed after a hand-sewn anastomosis, 12%, than after a stapled anastomosis, 4%, mean follow-up 6.5 years; $P=0.03$ [40]. Hahnloser *et al.* [41] reported 39% strictures in UC, follow-up 11 years, and Fazio *et al.* [2] described 14% strictures, follow-up 2.3 years.

In contrast to the aforementioned studies, in 266 IPAA reported by Senapati *et al.* [42] strictures were more frequent in stapled anastomoses than in hand-sewn anastomoses. Strictures were reported in 31 (14.2%) of the hand-sewn anastomoses and in 19 (39.6%) of the stapled anastomoses. The mean follow-up duration was not reported.

In a large study from Cleveland, low stricture rates were reported, 47 strictures in 2120 IPAA (2.2%) [34]. However, the mean follow-up duration was not reported.

Although the median follow-up was over 11 years after IPAA, the pouch failure rate was low, 2.4% compared with other publications, reporting pouch failure rates of 6.8–10.5% [24,43,44]. This may be explained by the low rate of hand-sewn anastomoses in our study, 7.3%, and by the low anastomotic leak rate of 0.81%. The two patients who had their pouches removed because of poor function had received short-course preoperative radiotherapy and TME surgery for rectal cancer. Radiotherapy is associated with considerable long-term effects on anorectal function, especially in terms of bowel frequency and faecal incontinence [45]. Anal manometry may be useful in the preoperative decision-making of irradiated patients [46].

Only one of our patients developed a fistula, which occurred almost 10 years after the IPAA. Thus, it is unlikely that this was a result of an undetected anastomotic leak. Our low anastomotic leak rate might be explained by preservation of the mesorectum, which was also suggested by Rink *et al.* [47]. Hand-sewn anastomosis, anastomotic leak [24,43] and no diverting loop ileostomy [43] have been associated with pouch failure. Another factor that might have contributed towards the low anastomotic leak rate in our study was that neostigmine was not administered to any of the patients during the administration of anaesthesia to reverse the muscle relaxant. Neostigmine has been described by some authors to increase the anastomotic leak rate [48,49]. This finding was not confirmed by others [50,51].

The overall pouchitis rate of 33% in our population-based study was in agreement with other studies presenting pouchitis rates of 23–62.5% [2,6,41,52].

We found that the presence of PSC and age younger than 40 years were significantly associated with a three- and two-fold increased risk of pouchitis, respectively. The association between PSC and pouchitis has also been confirmed by others [53–55].

In a large Swedish cohort, appendectomy for an inflammatory condition has been shown to be associated with a low risk of subsequent UC in patients who undergo appendectomy before the age of 20 years [56]. An inverse association between appendectomy and UC was also confirmed in a previously published large meta-analysis [57]. Investigation of the pathogenic factors involved will require further studies of the immunological role of the appendix [58]. Different types of helper T cells may be involved [56,59,60].

In the Cox regression analysis, we were not able to find a significantly lower incidence of pouchitis in patients who had undergone an appendectomy before colectomy than in patients without a history of appendectomy before colectomy. Because of the small sample size, an association cannot be ruled out. It would be interesting to evaluate whether there is an association in a study involving a large sample size.

The rate of SBO in this study was 12.9%. Fazio *et al.* [2] reported 25.3% SBO and Hahnloser *et al.* [41] presented a 20-year rate of 42% SBO. However, in a large meta-analysis, the pooled incidence of SBO in 11 895 patients was 11.4% since 2000 and 13.1% in 5853 patients before 2000 [61]. This incidence is exactly in line with our study.

Traditionally, closure of the loop ileostomy is deemed a minor surgical procedure and is not unusually performed by junior surgeons [7]. A possible contributing explanation for a low rate of SBO in the present study might be that we have considered stoma closure an important part

of the IPAA procedure. Thus, 95% of the stomas were closed by senior colorectal surgeons.

Conclusion

An experienced high-volume surgeon is essential for high-quality results in pouch surgery. IPAA is a safe procedure associated with a relatively low early morbidity as well as an acceptable late morbidity.

We were able to show that transition from using traditional electrocoagulation to an ultrasonically activated scalpel for perimuscular dissection significantly reduced the peroperative bleeding. Patients with complications had a higher median BMI than patients without complications. SBO was more common in female than in male patients. The presence of PSC and age younger than 40 years were significantly associated with a three- and two-fold increased risk of pouchitis, respectively.

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Conflicts of interest

There are no conflicts of interest.

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