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Article

Ileal Conduit Formation in Patients with Crohn's Disease Undergoing Pelvic Exenteration

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Abstract

Background/Objectives: Crohn's disease (CD) is traditionally considered a relative contraindication to ileal conduit (IC) urinary diversion, yet published evidence remains limited. This study evaluated urological complication rates and short-term outcomes of CD patients undergoing IC formation during pelvic exenteration (PE) for advanced pelvic malignancy and benign fistulae. **Methods:** An institutional prospective PE database (2008–2024) was analysed comparing patients with or without CD. The primary endpoint included urological complications (ureteroileal anastomotic leak and stricture, conduit leak, and stenosis) and need for re-intervention (nephrostomy, antegrade stents, revision surgery). Statistical analysis included Fisher-exact and Mann–Whitney-U tests ($p \leq 0.05$), with multivariate regression controlling for age, disease factors, and operative complexity. **Results:** Among 441 patients who underwent IC formation, 12 had CD. The CD cohort was younger and more commonly had recurrent rectal cancers (67.0% vs. 34.0%; $p = 0.02$), requiring more complex resections including sacrectomy (83.0% vs. 52.0%; $p = 0.04$) and experiencing greater blood loss (5000 vs. 2400 mL; $p = 0.04$). CD patients had higher overall urological complication rates (41.7% vs. 13.3%; $p = 0.017$) and re-intervention was more frequent, including percutaneous nephrostomy (41.7% vs. 11.2%; $p = 0.009$) and revision surgery (25.0% vs. 4.7%; $p = 0.02$). On multivariate analysis, CD remained independently associated with need for re-intervention (odds ratio [OR] = 4.48, 95% confidence interval [CI] = 1.35–14.89; $p = 0.014$). **Conclusions:** CD does not appear to preclude IC formation in PE surgery. Despite potentially higher urological complication risk in a complex surgical cohort, the results of this study highlight its feasibility in selected patients managed in a high-volume centre.

Keywords: pelvic exenteration; urinary diversion; cystectomy; postoperative complications; Crohn's disease

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1. Introduction

Pelvic exenteration (PE) represents the most radical and often last line definitive treatment in locally advanced and recurrent pelvic malignancies [1] and benign pathologies such as complex fistulae [2]. Patients with Crohn's disease (CD) are at elevated risks of developing colorectal malignancies, particularly rectal adenocarcinoma [3] as well as complex pelvic fistulae [4], which may require such radical treatment as PE. Inherent to many cases in PE is the need to perform cystectomy and excision of the urinary tract, demanding reconstruction, with ileal conduit (IC) being the most commonly utilised method, supported by established reliability and low long-term failure rates [5,6].

Historically, CD has been considered a relative contraindication to IC formation [7]. Potential for the presence of active disease despite quiescence and its propensity to exist within the terminal ileum have been associated with high rates of anastomotic leaks, infections, and abscess formation, particularly following gastrointestinal surgery [8]. However, contemporary data to support this paradigm in urological reconstruction are limited, with evidence largely derived from case reports in an era well predating current surgical practice [9–11]. Consequently, the impact of CD on IC formation in highly complex pelvic surgery including PE remains unclear.

The aim of this study was to compare the rates of urological complications and short-term outcomes between patients with and without CD. This study is the first to date to evaluate such outcomes of IC formation in patients with CD undergoing PE.

2. Materials and Methods

2.1. Study Design, Setting, and Participants

This study was designed in accordance with Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [12]. This study was conducted in accordance with the ethical principles stipulated by the Declaration of Helsinki and reviewed and approved with a waiver of consent by the institutional Human Research Ethics Committee (Sydney Local Health District [SLHD] HREC, approval number X25-0003 & 2025/ETH02328).

Consecutive patients who underwent PE surgery with formation of ileal conduit urinary diversion between January 2008 and December 2024 were analysed. Data were collected retrospectively from chart review of a prospectively maintained database of all PE. Patients were divided into two cohorts based on prior history of CD.

PE was defined as resection of the rectum, primary tumour, or recurrence with en bloc resection of >50% of two or more pelvic organs and/or major pelvic neurovascular structures or bone [13]. All patients considered for PE routinely underwent pre-operative multiplanar imaging in the form of computed tomography (CT) and magnetic resonance (MR) imaging, and were discussed in a multidisciplinary team (MDT) attended by surgeons (colorectal, urology, orthopaedic, plastics/reconstructive), radiologists, and oncologists. Degree of resection (including nerve and vascular resection, sacrectomy) and reconstructive techniques (vertical rectus abdominis myocutaneous [VRAM] flap) were subject to disease, surgical, and patient factors following shared decision-making with the patient.

2.2. Variables and Study Outcomes

All patients were analysed for baseline demographic (age, sex, body mass index [BMI], American Society of Anaesthesiologists classification [ASA]), disease (indication [primary or recurrent malignancy or non-malignancy], urgency [elective or emergency], treatment intent [curative or palliative], pre-operative additional therapies [chemotherapy, radiotherapy]), and technical surgical variables (sacrectomy, major vascular or nerve resection, VRAM flap formation).

The primary outcome was the incidence rate of any urological complication requiring intervention (defined as any surgical or radiological intervention under anaesthesia, chiefly percutaneous nephrostomy, ureteric stent insertion, and/or revision surgery). Secondary outcomes included short-term surgical outcomes (blood loss, operating time, length of stay, 30-day major complication rate [Clavien–Dindo classification ≥ III], surgical margin), and mortality. Bowel, vascular, bony, or graft complications were not included in the analysis.

2.3. Statistical Methods

Cohorts were compared using Fisher-exact (categorical) and Mann–Whitney-U (continuous) tests. Univariate logistic regression was performed to determine association between demographic, disease, and operative complexity variables with urological complication requiring re-intervention. Variables with significant association in predicting re-intervention on univariate analysis ($p < 0.1$) were included into a backward multivariate regression model to account for covariates and expressed as adjusted odds ratios (aOR), with $p < 0.05$ considered statistically significant. All statistical analysis was performed using Statistical Package for Social Science (SPSS version 29.0, IBM, Armonk, NY, USA).

3. Results

A total of 441 patients were included in this study, with a total of 12 patients identified with a history of CD, and a median follow-up time of 39 months (interquartile range [IQR] 10.5–55 months, Table 1). Patients within the CD group were generally younger (median age 54 vs. 63 years, $p = 0.018$) and underwent more extensive or complex resection, with a greater proportion requiring sacrectomy (83.3 vs. 52.4%, $p = 0.041$). Indications for exenteration also differed, with the majority of CD patients having had recurrent rectal malignancy (66.7 vs. 33.6%, $p = 0.022$). There were no significant differences between cohorts with respect to prior chemoradiotherapy.

Table 1. Baseline demographic and disease characteristics compared between cohorts. All continuous variables expressed as median (IQR) and categorical variables expressed as number (proportion) unless otherwise specified.

Variables	Crohn's (n = 12)	No Crohn's (n = 429)	p
Sex, male (%)	9 (75.0)	303 (70.6)	0.743
Age, years	54 (45–62)	63 (55–70)	0.018
ASA, ≥III (%)	9 (75.0)	263 (61.3)	0.336
Previous radiotherapy (%)	7 (58.3)	326 (76.0)	0.177
Previous chemotherapy (%)	8 (66.7)	333 (77.6)	0.482
Exenteration intent, curative	12 (100)	398 (92.8)	0.412
Urgency of exenteration, elective	11 (91.7)	403 (93.9)	0.536
Indication			
Primary rectal	2 (16.7)	139 (32.4)	0.022
Recurrent rectal	8 (66.7)	144 (33.6)	
Other malignancy	1 (8.3)	139 (32.4)	
Non-malignancy	1 (8.3)	7 (1.6)	
Other procedures			
Sacrectomy	10 (83.3)	225 (52.4)	0.041
Major nerve resection	6 (50.0)	153 (35.7)	0.365
Major vascular resection	10 (83.3)	277 (64.6)	0.230
VRAM flap	4 (33.3)	81 (18.9)	0.258

IQR: interquartile range; ASA: American Society of Anaesthesiologists classification; VRAM: vertical rectus abdominis myocutaneous.

3.1. Primary Outcomes

Overall, CD was associated with an increased risk of overall urological complications (41.7 vs. 13.3%; $p = 0.017$) requiring re-intervention, particularly percutaneous nephrostomy insertion (41.7 vs. 11.2%, $p = 0.009$) and revision surgery (25.0 vs. 4.7%, $p = 0.02$; Table 2).

Table 2. Outcomes following pelvic exenteration with ileal conduit formation compared between patients with or without known Crohn's disease.

Outcome	Crohn's	No Crohn's	*p*
n	12	429	
Blood loss, mL	5000 (3000–9500)	2400 (1500–4500)	0.037
Operating time, h	13.0 (10.5–13.8)	10.7 (9.4–12.33)	0.129
Length of stay, d	26 (20–40)	28 (21–43)	0.752
30-day complication (C-D ≥ Grade III)	4 (33.3)	114 (26.6)	0.741
Surgical margin			
R0	8 (66.7)	359 (83.7)	0.150
R1/2	3 (25.0)	64 (14.9)	
Not assessable	1 (8.3)	6 (1.4)	
Urological complication (%)			
Overall	5 (41.7)	57 (13.3)	0.017
Ureteroileal anastomotic leak	2 (16.7)	22 (5.1)	0.13
Ureteroileal anastomotic stricture	2 (16.7)	17 (4.0)	0.09
Conduit leak/breakdown	1 (8.3)	11 (2.6)	0.29
Conduit stenosis	0 (0)	5 (1.2)	>0.99
Other	0 (0)	9 (2.1)	>0.99
Urological intervention (%)			
Percutaneous nephrostomy	5 (41.7)	48 (11.2)	0.009
Antegrade stenting	2 (16.7)	29 (6.8)	0.20
Revision surgery	3 (25.0)	20 (4.7)	0.02

C-D: Clavien–Dindo.

Major complications following IC formation in either cohort included ureteroileal anastomotic leak (16.7 vs. 5.1%, $p = 0.13$), ureteroileal anastomotic stricture (16.7 vs. 5.1%, $p = 0.13$), conduit leak (8.3 vs. 2.6%, $p = 0.29$), or conduit stenosis (0 vs. 1.2%). No specific complication was found to be statistically significantly increased.

Multivariate regression analysis (Table 3) revealed three variables independently associated with urological complication requiring re-intervention: CD (aOR 4.48, 95% confidence interval [CI] 1.35–14.859, $p = 0.014$), prior radiotherapy (aOR 1.92, 95% CI 1.07–3.43, $p = 0.029$), and length of stay (aOR 1.01, 95% CI 1.00–1.02, $p = 0.002$).

Table 3. Association between urological complications requiring intervention (percutaneous nephrostomy, antegrade stenting, reconstruction) with surgical characteristics on multivariate and univariate analysis.

Variable	Univariate Analysis			Multivariate Analysis		
	R^2	Coefficient (95% CI)	*p*	R^2	Coefficient (95% CI)	*p*
Male sex	0.000	0.99 (0.55–1.79)	0.967	0.044		
Indication	0.002	1.19 (0.85–1.66)	0.309			
Age	0.000	1.00 (0.98–1.03)	0.866			
ASA (≥III)	0.000	0.98 (0.57–1.70)	0.946			
Sacrectomy	0.004	1.46 (0.85–2.53)	0.175			
Major nerve resection	0.005	0.63 (0.35–1.14)	0.129			
Major vascular resection	0.005	0.65 (0.38–1.13)	0.126			
Preoperative radiotherapy	0.013	2.04 (1.16–3.60)	0.014		1.92 (1.07–3.43)	0.029
Preoperative chemotherapy	0.002	1.35 (0.73–2.48)	0.337			

Table 3. *Cont.*

Variable	Univariate Analysis			Multivariate Analysis		
	R^2	Coefficient (95% CI)	*p*	R^2	Coefficient (95% CI)	*p*
Palliative exenteration	0.000	1.19 (0.44–3.23)	0.731			
Urgency (Emergency)	0.003	1.83 (0.71–4.72)	0.214			
Intraoperative blood loss	0.003	1.36 (0.79–2.32)	0.269			
Operating time	0.005	1.52 (0.88–2.62)	0.133			
Length of stay	0.013	1.99 (1.13–3.48)	0.017		1.01 (1.00–1.02)	0.002
Crohn's	0.013	4.66 (1.43–15.19)	0.011		4.48 (1.35–14.89)	0.014

CI: confidence interval; ASA: American Society of Anaesthesiologists classification.

3.2. Secondary Outcomes

Patients with CD underwent potentially more extensive and complex resection overall demonstrated on the intraoperative parameter of blood loss (5000 vs. 2400 mL, $p = 0.037$); however, no significant differences were detected in terms of operating time (13.0 vs. 10.7 h, $p = 0.13$), overall hospital length of stay (26 vs. 28 days, $p = 0.75$), or 30-day major complication rate (≥III, 33.3 vs. 26.6%, $p = 0.74$).

Resection margins were equivalent between the two groups and there was no statistically significant detectable difference in survival post PE, with equivalent median survival (31 vs. 50 months) (Figure 1).

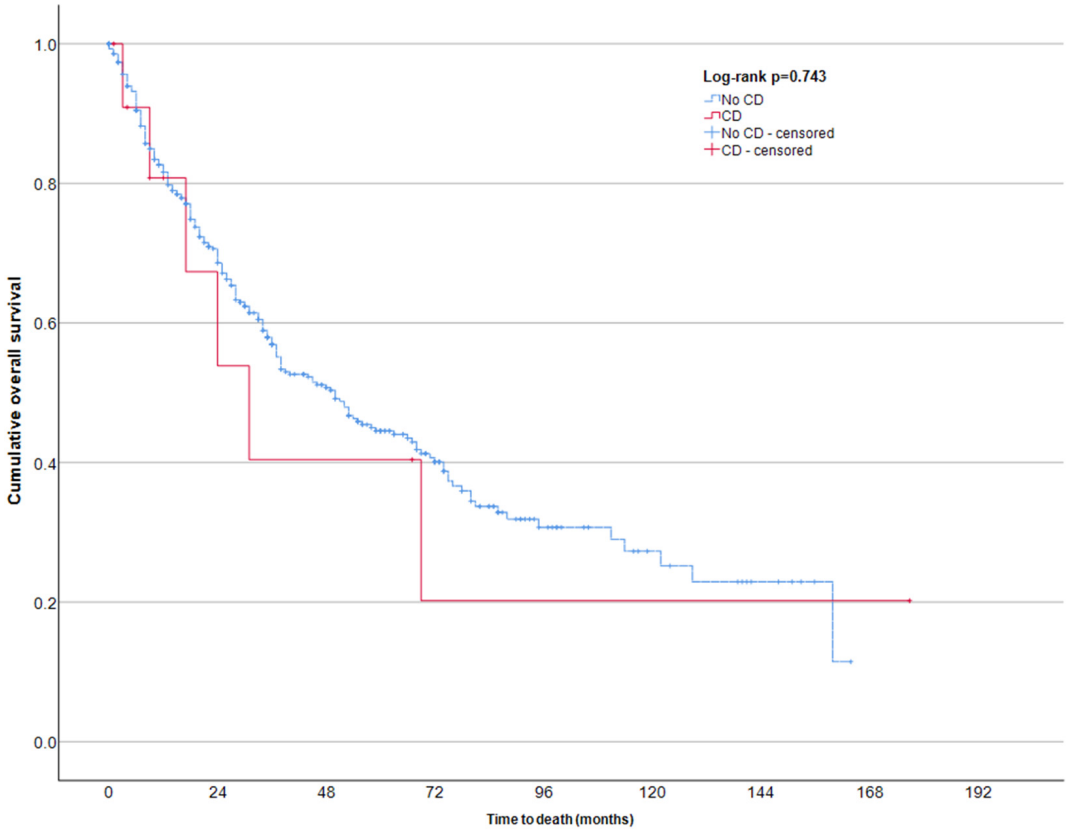


Figure 1. Kaplan-Meier curve of overall survival following pelvic exenteration with ileal conduit formation compared between Crohn's Disease and non-Crohn's Disease. CD: Crohn's disease.

4. Discussion

The use of ileum for urinary diversion in patients with CD is considered controversial, though this is based on limited evidence and is sparsely reported. The principles of use of intestinal segments for urinary diversion (UD) are well described by Dmochowski et al., emphasising the need for well-perfused, healthy bowel and reliable anastomotic healing, with conditions compromising bowel integrity including inflammatory bowel disease (IBD) regarded as relative contraindications to their use [14]. Published reports from the International Continence Society and other expert groups assert that although CD is not an absolute contraindication, it confers increased risks [7,15], particularly for anastomotic complications, infections, stomal stenosis [11], and development of CD disease within the conduit [10,16]. Active inflammatory disease of the bowel segment is subsequently considered to be an absolute contraindication for the use of ileum in UD [7].

Bowel anastomotic complications are known to be higher in CD patients [17], although the pathophysiology is poorly understood. Proposed mechanisms include compromise of end-vasculature and reduced bowel blood flow secondary to calcitonin gene-related peptides, particularly in segmental CD [18]. Theoretically, these same mechanisms at the ureteroileal anastomosis, where healing relies on an already tenuous blood supply to both the distal ureter and the isolated ileal segment in CD, could lead to a higher rate or urological complications in patients with CD undergoing IC, including leak and stricture formation.

Where feasible, other options for urinary diversion in CD include colonic conduits [19] and double-barreled 'wet' colo-urostomies, which have shown safety and low complication rates [20,21]. Neither were options in our cohort, as there was either no remaining colon (n = 11) or very limited colon (n = 1), where it was deemed not feasible to anastomose ureters to remaining transverse colon as a double-barrel colo-urostomy. Ivaz et al. [22] and Kimura et al. [23] have reported using stomach as an alternative to ileum in CD with reasonable success. However, gastric conduits are known to be associated with significant longer-term complications, including electrolyte disturbances [24] and development of gastric adenocarcinoma [25]. Other options such as ureterocutaneostomy and permanent nephrostomies were also not utilised in this non-palliative cohort.

The current study is the first to report the outcomes of patients with CD who underwent IC formation in PE. The results suggest that the rate of urological complications associated with the IC were higher in CD compared to non-CD patients (41.7% vs. 13.3%, p = 0.017). CD was associated with a higher rate of overall urological complication requiring intervention on multivariable regression analysis (aOR 4.8, p = 0.014), which also reflects the more extensive and complex surgery required in CD patients. There was no one single complication type that was statistically more frequent in CD, though stricture and leak at the ureteroileal anastomosis were the leading causes. On review of disease history and clinical variables for the CD cohort to assess whether disease quiescence or macroscopic disease activity within utilised bowel segments had an impact on complication rate, no significant relationship could be demonstrated—no patient in the cohort has macroscopically active CD (Supplementary Table). Previously reported increased risks of stoma complications, particularly stenoses and retraction [26], were not redemonstrated in our cohort. Despite the higher risk of urological complication, our study demonstrates that IC formation in CD patients undergoing PE may be considered in this challenging patient group.

The results also reaffirm that radiotherapy is a major risk factor for complications following urinary diversion [27]. Radiotherapy induces localised ischemia and peri-ureteric fibrosis, which can worsen the already tenuous ureteric blood supply, leading to ureteroenteric anastomotic stricture and leak [28]. On multivariate analysis, radiotherapy was

associated with a nearly two-fold increase in odds of urological complications requiring intervention. Given that both radiotherapy and CD independently have the propensity for higher complication rates in IC formation, reconstructive surgeons should be cognisant that the concomitance of both factors potentially confers high risk. In the era of neoadjuvant radiotherapy across a wide range of oncological applications [29], in particular in PE [30], this is a risk that is increasingly encountered.

Despite being a small cohort, the presented data represent the largest study demonstrating relative safety of IC formation in CD in the context of highly complex surgery. Given that this cohort of patients was historically considered unsuitable for IC formation, the presented experience may provide some indication that these patients may be safely managed in a high-volume centre with appropriate patient selection. These results highlight the challenges in urinary reconstruction in these high-risk patients, and the findings may be used to justify exploration if these are generalisable to other indications for reconstruction, including radical cystectomy for bladder malignancy and urinary diversion for other benign pathologies such as fistulae, infection, or functional disorders.

The limitations of this study are its retrospective analysis of a relatively small cohort, which limits the level of evidence from which conclusions can be drawn. Furthermore, our CD patients were identified as high-complexity surgical cases, which may confound results; however, multivariate analysis did demonstrate an independent role of CD in complication rates. Future studies could consider multi-centric review and data pooling of CD patients to assess outcomes in a larger cohort.

5. Conclusions

Though historically contraindicated, CD does not preclude IC formation. This comparative study of a single institution experience highlights that reasonable urological outcomes may be achieved in selected CD patients undergoing IC formation as part of PE surgery in a high-volume centre.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/siuj7050070/s1. Supplementary Table.

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Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors on request.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

ASA	American Society of Anaesthesiologists classification
BMI	Body mass index
CD	Crohn's disease
IC	Ileal conduit
MDT	Multidisciplinary team
PE	Pelvic exenteration
UD	Urinary diversion
VRAM	Ventral rectus abdominis myocutaneous flap
STROBE	Strengthening the Reporting of Observational Studies in Epidemiology
CT	Computed tomography
MR	Magnetic resonance
IQR	Interquartile range
CI	Confidence interval
aOR	Adjusted odds ratio
SLHD	Sydney Local Health District
HREC	Human Research Ethics Committee
IBD	Irritable bowel syndrome

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