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Original Article

Postoperative complications and waiting time for surgical intervention after radiologically guided drainage of intra-abdominal abscess in patients with Crohn's disease

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Abstract

Background: In patients with active Crohn's disease (CD), treatment of intra-abdominal abscess usually comprises antibiotics and radiologically guided percutaneous drainage (PD) preceding surgery. The aim of this study was to investigate the risk of postoperative complications and identify the optimal time interval for surgical intervention after PD.

Methods: A multicentre, international, retrospective cohort study was carried out. Details of patients with diagnosis of CD who underwent ultrasonography- or CT-guided PD were retrieved from hospital records using international classification of disease (ICD-10) diagnosis code for CD combined with procedure code for PD. Clinical variables were retrieved and the following outcomes were measured: 30-day postoperative overall complications, intra-abdominal septic complications, unplanned intraoperative adverse events, surgical-site infections, sepsis and pathological postoperative ileus, in addition to abscess recurrence. Patients were categorized into three groups according to the length of the interval from PD to surgery (1–14 days, 15–30 days and more than 30 days) for comparison of outcomes.

Results: The cohort comprised 335 CD patients with PD followed by surgery. Median age was 33 (i.q.r. 24–44) years, 152 (45.4 per cent) were females, and median disease duration was 9 (i.q.r. 3.6–15) years. Overall, the 30-day postoperative complications rate was 32.2 per cent and the mortality rate was 1.5 per cent. After adjustment for co-variables, older age (odds ratio 1.03 (95 per cent c.i. 1.01 to 1.06), $P < 0.012$), residual abscess after PD (odds ratio 0.374 (95 per cent c.i. 0.19 to 0.74), $P < 0.014$), smoking (odds ratio 1.89 (95 per cent c.i. 1.01 to 3.53), $P = 0.049$) and low serum albumin concentration (odds ratio 0.921 (95 per cent c.i. 0.89 to 0.96), $P < 0.001$) were

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associated with higher rates of postoperative complications. A short waiting interval, less than 2 weeks after PD, was associated with a high incidence of abscess recurrence (odds ratio 0.59 (95 per cent c.i. 0.36 to 0.96), $P = 0.042$).

Conclusion: Smoking, low serum albumin concentration and older age were significantly associated with postoperative complications. An interval of at least 2 weeks after successful PD correlated with reduced risk of abscess recurrence.

Introduction

Spontaneous intra-abdominal abscesses (IAAs) occur in up to 20 per cent of patients with active Crohn's disease (CD). The pathophysiology is transmural inflammation of the intestine, which can lead to deep fissuring ulceration followed by minor perforation of the bowel wall. The preferred initial treatment of IAA is antibiotics and percutaneous drainage (PD) under guidance from ultrasonography (US) or computed tomography (CT). It is indicated for technically accessible, well defined, unilocular abscesses when expertise in interventional radiology is available[1]. Management of IAA with PD may prevent surgery in some patients with a CD spontaneous IAA[1]. Simultaneous surgical drainage of the abscess and bowel resection is associated with a significantly higher rate of overall complications compared with image-guided PD[2]. PD alone is associated with a significantly higher risk of abscess recurrence compared with PD followed by elective surgery[1].

Nevertheless, the combination of IAA with active CD is still a challenge. It should be managed by a multidisciplinary team composed of colorectal surgeons, gastroenterologists, radiologists, microbiologists and nutritionists[1,3,4]. PD may work as a bridge to elective surgery, allowing time for sufficient supportive therapy, including nutritional supplements, bowel rest and steroid withdrawal before definitive elective surgery. Although surgery, in the form of bowel resection with or without primary anastomosis, is indicated in most cases, the optimal timing of surgical intervention after image-guided drainage is unknown. The current literature consists of small retrospective case series[3]. Many of these studies have examined heterogeneous cohorts of patients, including those with postoperative IAAs, abscesses confined to the abdominal wall and psoas abscesses[1].

The primary aim of this study was to investigate the postoperative complications after radiologically guided percutaneous drainage or aspiration of spontaneous IAA in patients with CD. The secondary aim was to determine the optimal time interval for surgical intervention after successful PD.

Methods

Study design

This is a multicentre, international, retrospective cohort study of patients with CD who underwent PD followed by surgery. All the participating centres are tertiary referral centres in Europe and the USA. The authors were invited through OpenSourceResearch Collaboration (OSRC). OSRC is a non-profit, international organization that promotes the implementation of information technology in clinical research[5]. OSRC has a vast network on social media to facilitate recruitment of participants, design and conduct of clinical research (https://www.opensourceresearchcollaboration.net/). Patients were included if they had a diagnosis of active CD and a radiological diagnosis of IAA, were aged 15 years or more and underwent a CT- or US-guided drainage of IAA, followed by elective, expedited (within 3–14 days) or urgent/acute (within 48 hours) operation (laparoscopic or open surgery) from May 1994 to May 2020. Patients were excluded if they had surgery for CD with no bowel resection such as diagnostic laparoscopy or strictureplasty. The study was carried out in accordance with the principles of the Declaration of Helsinki. Local investigators obtained the required ethical approvals in accordance with local jurisdictions in the respective countries.

Data extraction

A list of patients with CD diagnosis who underwent US- or CT-guided PD was retrieved from hospital records using international classification of disease (ICD-10) diagnosis code for CD combined with the procedure code for PD. Patients' records were then reviewed and data on patients' demographics, smoking, diabetes, disease duration, BMI, previous laparotomy/laparoscopy for CD were registered in clinical registration form according to the predefined study protocol. Medications for CD were registered with details including type, dose and date of administration of last dose of biological agents (within 8 weeks), immunomodulators (within 4 weeks) and steroids (within 1 week) prior to PD and surgery. Medications for CD were registered prior to PD, after PD and prior to surgical intervention. Size of abscess (maximum diameter) and results of culture/sensitivity analysis were obtained as well as serum albumin and haemoglobin concentrations, and details of the surgical procedure.

Outcomes

The outcomes were the risk of 30-day postoperative complications classified according to Clavien–Dindo classification[6], and identification of the optimal time interval between abscess drainage and bowel resection with respect to the postoperative outcome. Outcomes also included the following: postoperative complications (intra-abdominal septic complications (IASCs), unplanned intraoperative adverse events (UIAEs), surgical-site infection (SSI), sepsis and pathological postoperative ileus (POI)) and abscess recurrence.

IASCs were defined as an overt anastomotic leak, IAA and/or enteric fistula. Overt anastomotic leak was defined as clinical signs and symptoms of peritonitis or faecal discharge from the wound and/or drain confirmed by CT scanning or radiological contrast examination. UIAE was defined as any event that deviates from the expected surgical procedure leading to damage of an organ or bleeding. Surgical-site infection (SSI) was classified as involving only the skin and subcutaneous tissue (superficial incisional SSI) or involving deep soft tissues (for example, fascial and muscle layers) of the incision (deep incisional SSI). Sepsis was defined by the presence of both infection and systemic inflammatory response syndrome: microbiologically confirmed or strongly suspected infection and two or more of the following: temperature above 38°C or below 36°C; heart rate greater than 90 beats per minute; respiratory rate greater than 20 breaths per minute or partial pressure of carbon dioxide in arterial blood less than 32 mmHg; white blood cell count greater than 12×10^9/l or less than 4×10^9/l or greater than 10 per cent band forms. Pathological POI was defined as delayed gastrointestinal recovery of more than 5 days that was associated with an increased risk of

postoperative adverse events, which include malnutrition, pneumonia and acute kidney injury. Recurrence of an abscess was defined as the recurrence of IAA diagnosed more than 30 days after surgery in patients with CD who had preoperative PD. Abscess within 30 days of surgery was considered to be a complication of surgical intervention.

Waiting interval

The patients were divided into three groups according to the length of the interval of watchful waiting after PD, taking into consideration the clinical practice in the management of patients with CD. A pragmatic division of the time interval between radiologically guided abscess drainage and surgery was adopted: group 1, short interval (1–14 days); group 2, intermediate interval (15–30 days); group 3, long interval (more than 30 days).

Statistical analysis

SPSS (IBM Corp, Armonk, NY) version 26 was used for the analysis of data. As most of the continuous variables did not have a normal distribution (Kolmogorov–Smirnov) they were reported using median (i.q.r.). For the categorical variables, bivariable analysis, Pearson χ^2 and Fischer's exact tests were employed. Quantitative continuous data were compared with the Mann–Whitney *U* test and ANOVA test for parametric data. Logarithmic transformation was used for variables that were not normally distributed. Multivariable and binary logistic regression were used to investigate outcomes including abscess recurrence, postoperative complications, stoma construction, readmission and duration of postoperative stay at hospital. Adjustment for confounders was done by stepwise backwards elimination, starting with a model including all pre- and perioperative characteristics deemed clinically or statistically significant ($P \leq 0.100$). Variables were then removed one by one until all variables had $P < 0.05$. Two-sided $P < 0.05$ was considered to be statistically significant. Missing data were excluded from analyses. The time interval between abscess drainage and surgery was determined using visual binding in SPSS statistics software, calculating mean time ± one standard deviation.

A further analysis was performed by excluding patients who had PD before 2007 to reduce the bias associated with improvement of PD techniques in last decade. Patients who had PD followed by urgent surgical intervention were thus excluded. This analysis was performed to test the effect of the shortest waiting interval on abscess recurrence rates.

Results

Data from 19 tertiary centres for the treatment of CD were collected. The study population comprised 335 patients who had PD followed by surgery (*Fig. 1*). The median age was 33 (i.q.r. 24–44) years and the median BMI was 22 (i.q.r. 19.6–24.6) kg/m^2. Of the 335 patients, 152 (45.4 per cent) were females. The median duration of disease was 9 (i.q.r. 3.6–15) years. The median of the maximum diameter of the abscess was 50 (i.q.r. 30–70) mm. One-third of the patients were smokers or ex-smokers, and one-third of the patients had previous laparoscopy/laparotomy for CD (*Table 1*). The median duration of stay in hospital following surgery was 8 (i.q.r. 6–12) days. About two-thirds of the patients, 206 (61.5 per cent), had ileocaecal or ileocolic CD (L1 according to the Montreal classification of CD)[7]. These patients underwent laparoscopic ileocaecal or ileocolic resection. Other types of resections included: small bowel resection in 8.1 per cent of patients, colectomies in 14 per cent, rectum resection in 2 patients (0.6 per cent) and combination of resections in the remaining 12.2 per cent.

The most used medical treatment both before and after PD was steroids in 172 (51.3 per cent) and 115 patients (34.3 per cent) respectively. One-third of the patients (36.7 per cent) had nutritional support in form of oro- or nasogastric tube (14 of 119 patients, 11.8 per cent), parenteral nutrition (73 of 119, 61.3 per cent) and combined (32 of 119 patients, 26.9 per cent).

Postoperative complications

Overall, the 30-day postoperative complications rate was 32.2 per cent (108 of 335 patients), and the mortality rate was 1.5 per cent (5 of 335 patients). In univariable analysis, age, smoking, diabetes, low serum albumin concentration, preoperative IAA, preoperative

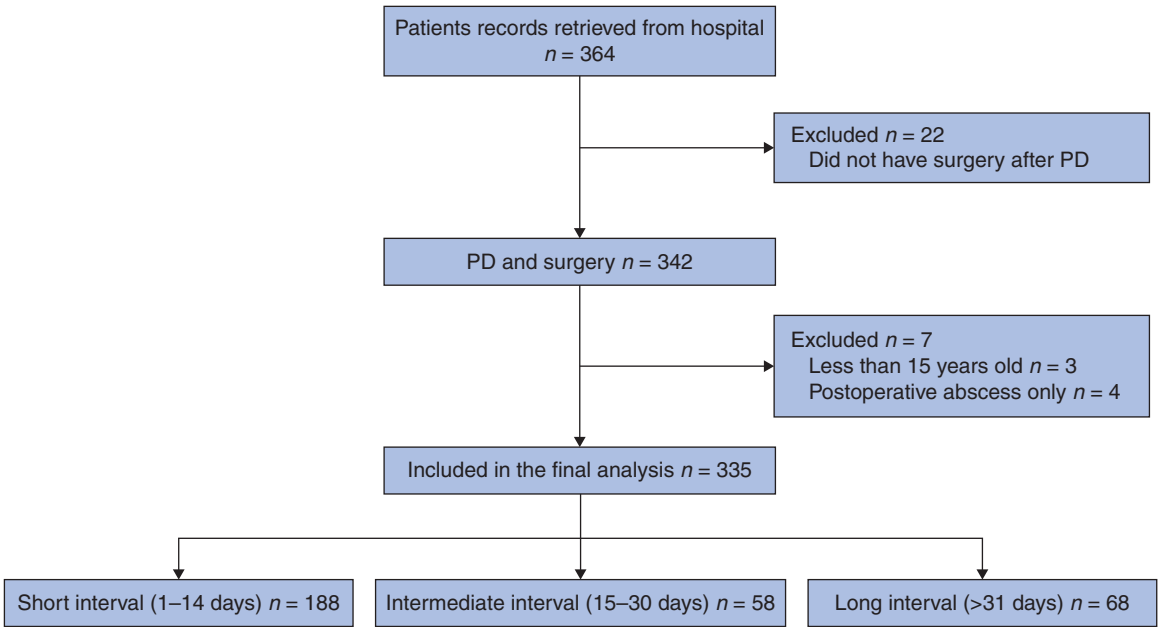

Fig. 1 Patients with Crohn's disease who underwent ultrasound- or CT-guided percutaneous drainage for intra-abdominal abscess followed by surgery

Table 1 Characteristics of patients with Crohn's disease who underwent ultrasound- or CT-guided percutaneous drainage for intra-abdominal abscess followed by surgery

Characteristic	Result ($n = 335$)
Patient demographics	
Age (years)*	33 (24–44)
Female patients	152 (45.4)
BMI (kg/m^2)*	22.1 (19.6–24.6)
Smoking history	
Smoker	78 of 330 (23.3)
Ex-smoker	37 of 330 (11)
Non-smoker	215 of 330 (64.2)
Diabetes	17 of 287 (6.1)
Duration of disease (years)*	9 (3.6–15)
Previous laparoscopy or laparotomy	118 (35.2)
Intra-abdominal abscess size and treatment before PD	
Median intra-abdominal abscess size (mm)†*	50 (30–70)
Antibiotic	229 of 260 (88.1)
Any medical treatment for CD	224 (66.9)
Steroid within 1 week prior to PD	172 of 334 (51.5)
Immunomodulator within 4 weeks prior to PD	90 of 333 (27)
Biological agent within 8 weeks prior to PD	82 (24.5)
Treatment and other variables after PD	
Antibiotic	245 of 262 (93.5)
Any medical treatment for CD	182 of 334 (54.5)
Steroids after PD	115 of 319 (36.1)
Immunomodulator after PD	62 of 330 (18.8)
Biological agent after PD	63 of 330 (19.1)
Nutrition	118 of 307 (38.4)
Serum haemoglobin concentration (mmol/l)*	7.1 (6.3–7.9)
Serum albumin concentration (g/l)*	33 (28–39)

Values in parentheses are percentages unless indicated otherwise; *values are median (i.q.r.). The denominator might be different from the total number of patients in each group due to some missing values. †Maximum diameter of abscess. PD, percutaneous drainage; CD, Crohn's disease.

enteric fistula, stoma and UIAEs were associated with a higher risk of overall complications. After adjustment for co-variables, only older age (odds ratio 1.03 (95 per cent c.i. 1.01 to 1.06), $P < 0.012$), smoking (odds ratio 1.89 (95 per cent c.i. 1.01 to 3.53), $P = 0.049$), low serum albumin (odds ratio 0.921 (95 per cent c.i. 0.89 to 0.96), $P < 0.001$) and preoperative residual abscess (odds ratio 0.37 (95 per cent c.i. 0.19 to 0.74), $P < 0.014$) were associated with higher rate of postoperative complications (*Table 2*).

Interval between percutaneous drainage and surgical intervention

Table 3 shows the association between short, intermediate, and long waiting interval after PD and the postoperative outcome, and *Table 4* illustrates the factors associated with the choice of waiting interval. High incidence of abscess recurrence was associated with short waiting interval ($P = 0.001$), and patients with a long interval had a higher risk of having stoma construction ($P < 0.002$). Smoking, diabetes, duration of disease, antibiotics after PD, immunological treatment, treatment with biological agents, residual abscess after PD and preoperative enteric fistula were associated with longer waiting interval. However, in multivariable analysis only smoking (odds ratio 2.15 (95 per cent c.i. 1.04 to 4.44), $P = 0.047$), diabetes (odds ratio 0.10 (95 per cent c.i. 0.12 to 0.89), $P = 0.044$) previous laparotomy or laparoscopy (odds ratio 2.28 (95 per cent c.i. 1.08 to 4.78), $P = 0.038$) and preoperative fistula (odds ratio 2.318 (95 per cent c.i. 1.15 to 4.66), $P = 0.022$) were predictors for choosing the longer waiting interval between PD and surgical intervention, whereas residual abscess after PD (odds ratio 0.49 (95 per cent c.i. 0.20 to 0.94), $P = 0.042$) was associated with shorter waiting interval (*Table 4*).

Recurrence of abscess and stoma construction

Factors associated with abscess recurrence in univariable analysis were urgent surgical intervention, any medical treatment prior to PD, treatment with steroids before PD, diabetes, duration of disease, preoperative IAA, preoperative enteric fistula and waiting interval.

In multivariable analysis, steroid treatment before drainage (odds ratio 2.96 (95 per cent c.i. 2.82 to 3.25), $P = 0.036$) and short waiting interval (odds ratio 0.59 (95 per cent c.i. 0.36 to 0.96), $P = 0.040$) were associated with a high risk of recurrence of abscess after PD, as shown in *Fig. 2* and *Table 5*. There was no difference in abscess recurrence between the patients who had primary anastomosis and those who did not. IASCs did not increase the risk of abscess recurrence. Anaemia (odds ratio 0.66 (95 per cent c.i. 0.51 to 0.85), $P < 0.001$) and long waiting interval (odds ratio 1.01 (95 per cent c.i. 1.0–1.01), $P = 0.036$) increased the risk of stoma construction after adjustment for co-variables (*Table 6*). Based on these results, the optimal interval to consider surgical intervention after successful PD is at least 2 weeks to reduce the risk of recurrence and allow optimization of the patient.

There was no significant change in the rate of abscess recurrence over the study period ($P = 0.7$). Excluding patients who had PD followed by urgent surgery did not change abscess recurrence rates (*Fig. S1*, supplementary material online).

Discussion

This study showed that older age, smoking, low serum albumin concentration and residual IAA were associated with a higher rate of postoperative complications following PD. Furthermore, a waiting interval of 2–4 weeks seems to be optimal for surgical intervention after successful PD of IAA in patients with CD, as this interval is associated with the lowest risk of abscess recurrence and stoma formation. There was no significant change in the rate of abscess recurrence over the study period but this must be interpreted with caution as no precise definition for successful PD was used in the centres involved.

A waiting interval of at least 2 weeks after successful PD is needed to control CD activity and achieve good preoperative optimization. A past study investigated the outcomes of early elective ileocolic resection after PD and found that patients undergoing early operative intervention after PD (after 7 days) had a higher risk of ileostomy and readmission[8].

The choice of waiting interval after successful drainage might be related to many factors: smoking, diabetes, disease duration, treatment with immunomodulators and biological agents, in addition to low serum albumin and haemoglobin levels reflecting compromised nutritional status. Unsuccessful PD leading to residual abscess after PD seems to be another factor that encouraged early intervention and increased the risk of postoperative complications.

In line with other studies, preoperative use of steroids[9], smoking[10], low serum albumin concentration[11,12] and residual abscess after PD[13] were significant risk factors of postoperative complications. The study did not include patients who did not have a bowel resection after IAA drainage. This group of patients might have risk factors that encouraged conservative treatment. It would be interesting to investigate the outcome after drainage in this group. Treatment with biological agents did not affect the outcome, confirming the findings from a recent review by an expert panel[14]. This emphasizes the role of preoperative optimization pathways[15,16] to be tackled in a multidisciplinary team with

Table 2 Predictors for postoperative complications and severe complications in patients with Crohn's disease after percutaneous drainage of intra-abdominal abscess followed by surgery

Factor	Patients with no postoperative complications ($n = 227$)	Patients with postoperative complications ($n = 108$)	Univariable analysis *P*	Multivariable analysis	
				Odds ratio†	*P*
Age (years)*	31 (23–41)	39 (28–50)	**<0.001**	1.03 (1.01, 1.06)	<0.012
Gender (female)	105 (46.0)	47 (44.0)	ns	–	
BMI (kg/m^2)*	22.1 (19.5–25.0)	22.1 (19.8–24.1)	ns	–	
Smokers and ex-smokers	67 of 222 (30.2)	48 (44.4)	**0.019**	1.89 (1.01, 3.53)	0.049
Diabetes	5 of 188 (82.7)	12 of 90 (13.3)	**<0.001**	–	
Duration of disease (years)*	9 (4–15)	8 (3–16)	ns	–	
Previous laparoscopy/laparotomy	75 (33.0)	43 (39.8)	ns	–	
Before drainage of abscess					
Abscess size (mm)*‡	48 (30–74)	50 (30–69)	ns	–	
Antibiotics before PD	149 of 174 (85.6)	80 of 86 (93)	ns	–	
Steroids before PD	118 of 227 (52.0)	54 of 107 (50.5)	ns	–	
Immunomodulator before PD	67 of 226 (29.6)	23 of 107 (21.5)	ns	–	
Biological agent before PD	58 of 227 (25.6)	24 of 108 (22.2)	ns	–	
After drainage of abscess					
Antibiotics after PD	161 of 175 (92.0)	84 of 87 (97)	ns	–	
Steroids after PD	77 of 212 (36.3)	38 of 107 (35.5)	ns	–	
Immunomodulator after PD	47 of 223 (21.1)	15 of 107 (14.0)	ns	–	
Biological agent after PD	48 of 223 (22.3)	15 of 107 (14.0)	ns	–	
Nutrition	72 of 204 (35.3)	46 of 103 (44.7)	ns	–	
Serum haemoglobin concentration (mmol/l)*	7.16 (7.00–7.32)	7.04 (6.85–7.24)	ns	–	
Serum albumin concentration (g/l)*	35 (30–40)	30 (22–36)	**<0.001**	0.92 (0.89, 0.96)	<0.001
Residual abscess after PD	116 of 191 (60.7)	72 of 91 (79)	**<0.007**	0.37 (0.19, 0.74)	<0.014
Preoperative fistula	80 of 191 (41.9)	50 of 91 (55)	**0.04**	–	
Urgent operation (within 48 hours)	77 of 210 (36.7)	37 of 104 (35.6)	ns	–	
Stoma construction	47 of 221 (21.3)	43 of 105 (41.0)	**<0.003**	–	

Values in parentheses are percentages unless indicated otherwise; For the categorical variables, bivariable analysis, Pearson $\chi 2$ and Fisher's exact tests were employed. Quantitative continuous data were compared with the Mann–Whitney U test and ANOVA test for parametric data. Logarithmic transformation was used for variables that were not normally distributed. Multivariable and binary logistic regression were used to investigate outcomes including abscess recurrence, postoperative complications, stoma construction, readmission and duration of postoperative stay at hospital. *values are median (i.q.r.); †values in parentheses are 95 per cent confidence intervals. The denominator might be different from the total number of patients in each group due to some missing values. ‡Maximum diameter of abscess. PD, percutaneous drainage; ns, non-significant.

Table 3 Association between length of waiting interval after ultrasound- or CT-guided percutaneous drainage of intra-abdominal abscess in patients with Crohn's disease and outcome after drainage

Outcome variable	Short interval (0–14 days) ($n = 188$)	Intermediate interval (15–30 days) ($n = 58$)	Long interval (more than 30 days) ($n = 68$)	Univariable analysis *P*
Overall postoperative complications	62 (33)	20 (35)	22 (32)	ns
Severe postoperative complications (grade 3 or more)	13 (7)	8 (14)	7 (10)	ns
Stoma construction	45 of 186 (24)	17 of 56 (30)	25 (36)	<0.002
UIAE	12 of 157 (8)	2 of 36 (6)	3 of 57 (5)	ns
Death	5 (3)	0 (0)	0 (0)	ns
Reoperation	19 of 186 (10)	6 of 56 (11)	9 of 63 (14)	ns
LOS (days)*	8 (6–12)	8 (6–11)	8 (6–12)	ns
Readmission	19 (10)	7 (12)	9 (13)	ns
Recurrence of abscess	33 (18)	5 (9)	5 (7)	0.001

Values in parentheses are percentages unless indicated otherwise; *values are median (i.q.r.). The denominator might be different from the total number of patients in each group due to some missing values. ns, non-significant; UIAEs, unplanned intraoperative adverse event; LOS: length of postoperative stay at hospital. Complications are classified according to Clavien–Dindo classification of surgical complications.

the aim of controlling disease activity and improving postoperative outcome according to well defined algorithms[17,18]. It might be safe to wait longer than 2 weeks if the patient's general health does not allow surgical intervention or the patient is asymptomatic. There is a growing need for standardized pre- and postoperative care programmes to ensure robust recommendations, comparable methods for measurements and reporting to permit data synthesis and transparent cross-study comparisons[19].

Approximately one-third of the patients in this cohort had urgent surgical intervention, probably with simultaneous surgical drainage of IAA. Urgent surgical intervention was associated with higher rates of postoperative complications and abscess

Table 4 Patients' demographic factors which were associated with the choice of the length of waiting intervals in a cohort of 335 patients with Crohn's disease who underwent ultrasound- or CT-guided percutaneous drainage for intra-abdominal abscess followed by surgery

Factor	Short interval (0–14 days) ($n = 188$)	Intermediate interval (15–30 days) ($n = 58$)	Long interval (more than 30 days) ($n = 68$)	Univariable analysis P	Multivariable analysis	
					Odds ratio†	P
Demographics						
Age (years)*	32 (24–45)	34 (25–48)	37 (27–43)	ns	–	
Gender (female)	84 (45)	30 (52)	30 (44)	ns	–	
BMI (kg/m^2)*	22 (19–24)	23 (20–26)	22 (20–24)	ns	–	
Smokers and ex-smokers	51 of 185 (27.6)	27 (47)	27 of 67 (40)	0.013	2.15 (1.04, 4.44)	0.047
Diabetes	16 of 160 (10)	0 of 40 (0)	1 of 59 (2)	0.028	0.10 (0.12 , 0.89)	0.044
Duration of disease (years)*	11 (5–16)	5 (1–12)	9 (2–18)	<0.007	–	
Previous laparoscopy/laparotomy for CD	58 (31)	24 (41)	31 (46)	ns	2.28 (1.08, 4.78)	0.038
Before drainage						
Abscess size (mm)*‡	50 (35–70)	42 (29–66)	50 (30–80)	ns	–	
Antibiotics before PD	130 of 150 (86.7)	36 of 39 (92)	46 of 54 (85)	ns	–	
Steroids before PD	97 (51.6)	34 (59)	27 of 67 (40)	ns	–	
Immunomodulator before PD	47 (25)	11 (19)	19 of 66 (29)	ns	–	
Biological agent before PD	50 (26.6)	8 (14)	16 (24)	ns	–	
After drainage						
Antibiotics after PD	135 of 149 (90.6)	40 of 40 (100)	56 of 54 (85)	0.033	–	
Steroids after PD	61 of 175 (34.8)	25 (43)	22 (32)	ns	–	
Immunomodulator after PD	29 of 186 (15.6)	6 of 57 (11)	19 of 67 (20)	0.028	–	
Biological agent after PD	43 of 185 (23.2)	4 of 57 (7)	13 (19)	0.037	–	
Nutritional support	75 of 169 (44.4)	16 of 57 (28)	24 of 66 (36)	ns	–	
Serum haemoglobin concentration (mmol/l)*	7.03 (6.87–7.19)	7.39 (7.05–7.73)	7.13 (6.87–7.39)	ns	–	
Serum albumin concentration (g/l)*	33 (28–38)	32 (27–40)	33 (28–39)	ns	–	
Residual abscess after PD	124 of 163 (76.1)	25 of 40 (63)	34 of 59 (58)	0.024	0.49 (0.20, 0.94)	0.042
Preoperative fistula	61 of 163 (37.4)	27 of 40 (68)	33 of 59 (56)	0.001	2.32 (1.15, 4.66)	0.022

Values in parentheses are percentages unless indicated otherwise; For the categorical variables, bivariable analysis, Pearson $\chi 2$ and Fischer's exact tests were employed. Quantitative continuous data were compared with the Mann–Whitney U test and ANOVA test for parametric data. Logarithmic transformation was used for variables that were not normally distributed. Multivariable and binary logistic regression were used to investigate outcomes including abscess recurrence, postoperative complications, stoma construction, readmission and duration of postoperative stay at hospital. *values are median (i.q.r.); †values in parentheses are 95 per cent confidence intervals. The denominator might be different from the total number of patients in each group due to some missing values. ‡Maximum diameter of abscess. CD, Crohn's disease; PD, percutaneous drainage; ns, non-significant.

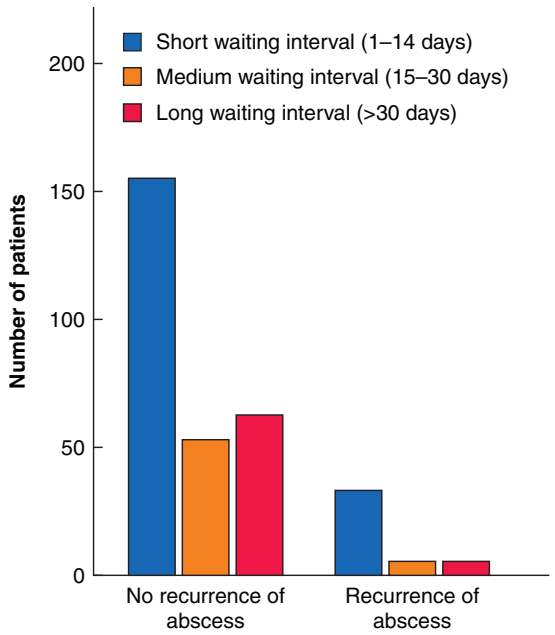

Fig. 2 Postoperative recurrence of abscess in patients with Crohn's disease who underwent ultrasound- or CT-guided percutaneous drainage for intra-abdominal abscess followed by surgery

recurrence, but the higher rate of postoperative complications was not significant after adjusting for co-variables. A recently published meta-analysis about timing of surgical intervention showed that urgent surgery is a risk factor for postoperative complications[20], which supports findings of the European Society of Colo-Proctology (ESCP) prospective audit[21] in which 375 patients with CD were investigated. One explanation might be the nature of patients in the present study comprising penetrating CD only, compared with the ESCP audit and meta-analysis in which all CD phenotypes were included. In the ESCP audit, 68 patients (18.1 per cent) had a preoperative IAA, however, only 18 (4.8 per cent) had their abscess drained before surgery, with a median interval between abscess drainage and surgery of 29 days. However, it must be emphasized that in patients with CD who have a life-threatening condition and are not fit for bowel resection, urgent intervention with stoma formation should be considered for damage control.

There was a high rate of stoma construction in this cohort (90 of 326 patients, 26.9 per cent). A higher risk of stoma construction was associated with a longer waiting interval. Patients who had stoma were probably those who were in need of a longer optimization time, as stoma construction was associated with low haemoglobin and albumin concentrations, residual abscess and enteric fistula. It might be assumed, therefore, that stoma construction was part of a two-stage approach to treat this particular group of patients. The question is whether the patients who had a successful PD need a surgical resection or it is sufficient with PD and watchful waiting under close follow-up . Another question is why patients who had bowel resection develop recurrent abscess. Resecting the inflamed bowel segment does not seem to solve the problem; this suggests that surgery alone is not sufficient treatment in this group of patients with CD.

Table 5 Factors and predictors associated with abscess recurrence after percutaneous drainage of intra-abdominal abscess in patients with Crohn's disease followed by surgery

Factor	No abscess recurrence ($n = 290$)	Abscess recurrence ($n = 45$)	Univariable analysis P	Multivariable analysis	
				Odds ratio†	P
Demographics					
Age (years)*	33 (25–46)	30 (22–39)	ns	–	
Gender (female)	136 (47)	16 (36)	ns	–	
BMI (kg/m^2)*	22 (19–24)	22 (20–27)	ns	–	
Smokers and ex-smokers	98 of 285 (34.4)	17 (38)	ns	–	
Diabetes	11 of 233 (4.7)	6 (13)	0.04	–	
Duration of disease (years)*	8 (3–14)	13 (5–17)	0.03	–	
Previous laparoscopy/laparotomy	105 (36)	13 (29)	ns	–	
Before drainage					
Abscess size (mm)†*	45 (30–70)	56 (40–83)	ns	–	
Antibiotics before PD	193 of 222 (86.9)	36 of 38 (95)	ns	–	
Steroids before PD	139 of 289 (48.1)	33 (73)	0.002	2.96 (2.82, 3.25)	0.036
Immunomodulator before PD	75 of 288 (26.1)	15 (33)	ns	–	
Biological agent before PD	68 (23.4)	14 (31)	ns	–	
After drainage					
Antibiotics after PD	208 of 244 (85.3)	37 of 38 (97)	ns	–	
Steroids after PD	96 of 281 (34.2)	19 of 38 (50)	ns	–	
Immunomodulator after PD	53 of 286 (18.5)	9 of 44 (21)	ns	–	
Biological agent after PD	51 of 286 (17.8)	12 of 44 (27)	ns	–	
Nutrition	106 of 272 (39)	12 of 35 (34)	ns	–	
Serum haemoglobin concentration (mmol/l)*	7.1 (6.4–7.9)	6.9 (6.2–7.8)	ns	–	
Serum albumin concentration (g/l)*	34 (28–40)	32 (25–38)	ns	–	
Residual abscess after PD	146 of 237 (61.6)	42 (93)	<0.001	–	
Preoperative fistula	117 of 237 (49.4)	13 (29)	0.014		
Urgent operation (within 48 hours)	88 of 281 (31.3)	26 of 43 (60)	0.001	–	
Stoma construction	79 of 281 (28.1)	11 (24)	ns	–	
Unplanned intraoperative adverse event	15 of 226 (6.6)	2 (5)	ns	–	
Waiting interval (days)*	17 (7–38)	14 (4–33)	0.012	0.59 (0.36, 0.96)	0.040

Values in parentheses are percentages unless indicated otherwise. For the categorical variables, bivariable analysis, Pearson $\chi 2$ and Fischer's exact tests were employed. Quantitative continuous data were compared with the Mann–Whitney U test and ANOVA test for parametric data. Logarithmic transformation was used for variables that were not normally distributed. Multivariable and binary logistic regression were used to investigate outcomes including abscess recurrence, postoperative complications, stoma construction, readmission and duration of postoperative stay at hospital.*values are median (i.q.r.); †values in parentheses are 95 per cent confidence intervals. ‡Maximum diameter of abscess.The denominator might be different from the total number of patients in each group due to some missing values. PD, percutaneous drainage; ns, non-significant.

Table 6 Factors associated with stoma construction in patients with Crohn's disease after ultrasound- or CT-guided percutaneous drainage of intra-abdominal abscess followed by surgery

Factor	No stoma construction ($n = 236$)	Stoma construction ($n = 90$)	Univariable analysis P	Multivariable analysis	
				Odds ratio†	P
Demographics					
Age (years)*	31 (24–43)	35.5 (26.4–46.9)	ns	–	
Gender (female)	107 (45)	40 (44)	ns	–	
BMI (kg/m^2)*	22.2 (19.9–25)	22 (18.6–24.2)	ns	–	
Smokers and ex-smokers	76 of 231 (32.9)	35 (38.9)	ns	–	
Diabetes	7 of 202 (3.5)	10 of 67 (14.9)	<0.01	–	
Duration of disease (years)*	9.7 (3–15)	8 (4–16)	ns	–	
Previous laparoscopy/laparotomy	76 of 236 (32.2)	39 (43.3%)	ns	–	
Before drainage					
Abscess size (mm)*‡	45 (30–70)	55 (35–75)	ns	–	
Antibiotics before PD	163 of 187 (87.2)	61 of 67 (91)	ns	–	
Steroids before PD	129 of 235 (53.2)	41 (456)	ns	–	
Immunomodulator before PD	65 of 235 (27.7)	24 of 89 (27)	ns	–	
Biological agent before PD	63 (26.7)	17 (19)	ns	–	
After drainage					
Antibiotics after PD	174 of 188 (92.6)	62 of 65 (95)	ns	–	
Steroids after PD	83 of 221 (37.6)	30 of 89 (34)	ns	–	
Immunomodulator after PD	46 of 233 (19.7)	13 of 88 (15)	ns	–	
Biological agent after PD	48 of 232 (20.7)	13 of 89 (15)	ns	–	
Nutrition	77 of 211 (6.5)	47 of 67 (70)	ns	–	
Serum haemoglobin concentration (mmol/l)*	7.3 (6.5–8.1)	6.8 (6.0–7.5)	<0.003	0.66 (0.51, 0.85)	0.001
Serum albumin concentration (g/l)*	34 (28–40)	31 (25–36)	0.010	–	
Residual abscess after PD	134 of 206 (65.0)	47 of 67 (70)	ns	–	
Preoperative fistula	83 of 206 (40.3)	41 of 67 (61)	<0.003	–	
Urgent operation (with 48 hours)	150 of 197 (76.1)	47 of 197 (24)	<0.001	–	

(continued)

Table 6. (continued)

Factor	No stoma construction ($n = 236$)	Stoma construction ($n = 90$)	Univariable analysis P	Multivariable analysis	
				Odds ratio†	P
Elective operation	86 of 129 (66.7)	43 of 129 (33)			
Unplanned intraoperative adverse event	7 of 197 (3.6)	7 of 64 (11)	0.050	–	
Waiting interval (days)*	16 (7–33)	17 (5–41)	<0.012	1.01 (1.00, 1.01)	0.036
Reoperation	16 (6.8)	18 of 90 (20)	<0.001	–	
Complications overall	62 (26.3)	43 of 90 (48)	<0.001	–	
Severe complications	9 (3.8)	19 of 90 (21)	<0.001	–	

Values in parentheses are percentages unless indicated otherwise; Complications are classified according to Clavian-Demartines-Dindo classification of surgical complications.*values are median (i.q.r.); †values in parentheses are 95 per cent confidence intervals. The denominator might be different from the total number of patients in each group due to some missing values. ‡Maximum diameter of abscess. PD, percutaneous drainage; ns, non-significant.

This study has some limitations. First, it was a retrospective study with the unavoidable bias associated with this type of design, including under-reporting bias. Second, the number of patients with IAA was unexpectedly small in all the centres that contributed to this study. One reason might be related to the size of the abscess. Patients with small abscesses are usually treated with antibiotics only and do not appear in the list of patients who had PD or attempted PD. These patients could not be retrieved for inclusion because they had no PD code. It is difficult to trace this in retrospective cohorts as most of the patients were tagged with CD diagnosis code and not IAA. To retrieve data, PD codes were used as these are registered accurately in radiology departments. Third, the authors did not have information about CD activity and patients' reported outcome measures, which are important in evaluating any outcome after surgical interventions[22].

This is one of the largest cohorts analysed, however. Results from this study can certainly be used to guide clinical decision making while awaiting large, multicentre prospective studies.

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A.E., N.N.U.N. and M.L.M.K. contributed to the conception and design of the study, statistical analysis and writing the manuscript. C.S. contributed to statistical analysis, acquisition and interpretation of data. C.A.R. contributed to statistical analysis. All authors contributed to the acquisition and interpretation of the data, writing the first draft, revising the article critically for important intellectual content and approving the final version of the article to be published. All authors agree to be accountable for all aspects of the work and A.E. holds overall responsibility for the content and integrity of the paper . The data underlying this article were provided by different hospitals under different permissions. Data will be shared on request to the corresponding author with permission of hospitals that collected this data.

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Supplementary material

Supplementary material is available at *BJS Open* online.

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