

Natural history of percutaneous drainage of postoperative collection following colorectal surgery: in which patients can follow-up imaging be dispensed with before drain removal?

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Abstract

Introduction: Colorectal surgery is complicated by postoperative collections in up to 25% of cases depending on local conditions. The aim of this study was to identify predictive factors of success of percutaneous drainage of collections in order to avoid follow-up imaging.

Patients and methods: All consecutive patients between January 2009 and December 2016, who had undergone elective or emergency colorectal surgery (colorectal surgery and appendectomy) complicated by a postoperative collection treated by percutaneous drainage with follow-up imaging prior to drain removal, were included in this single-center and retrospective study. The primary objective was to assess predictive factors of success of the first attempt of percutaneous drainage of collections. Secondary objectives were to describe the natural history of percutaneous drainage of postoperative collections after colorectal surgery and the overall success rate of percutaneous drainage.

Results: Fifty-three patients underwent percutaneous drainage of a postoperative collection during the study period and were included in this study. Complete resolution of the collection was observed on the first follow-up radiological examination in 36 patients (58%). In multivariate analysis, post-appendectomy collections (OR = 3.19 (1.14–9.27), $p = 0.002$) and reduc-

tion of the leukocyte count (OR = 3.22 (1.28–8.1), $p = 0.013$) were significantly associated with success of percutaneous drainage.

Conclusion: This is the first study to address that follow-up imaging prior to drain removal might not be necessary in patients undergoing drainage of post-appendectomy collections and/or with more than 30% reduction of the leukocyte count at the first follow-up examination.

Key words: Percutaneous drainage—Radiological guidance—Intra-abdominal collection—Postoperative collection

Colorectal surgery is complicated by postoperative collections in up to 20% of cases depending on local conditions and type of surgery [1]. These collections require specific management by antibiotic therapy, sometimes associated (depending on the characteristics of the collection) with percutaneous drainage. Treatment of intra-abdominal collections by percutaneous drainage ensures a significant reduction of morbidity and mortality, length of stay, and cost of treatment compared to surgical treatment. The percutaneous drainage success rate is 90% [2–8]. Few studies have tried to identify predictive factors for success of percutaneous drainage in order to optimize selection of patients requiring drainage and their management [9–11]. Systematic follow-up imaging, which is currently the rule, may be unnecessary in certain situations, thereby reducing exposure to X-rays,

avoiding unnecessary patient transfers and unnecessary occupation of computed tomography facilities and limiting the length of stay.

The objective of this study was to identify predictive factors of success of percutaneous drainage of collections in order to dispense with systematic follow-up imaging.

Patients and methods

Population and study design

From January 2009 to December 2016, all consecutive patients who underwent elective or emergency colorectal surgery (colorectal surgery and appendectomy) complicated by a postoperative collection treated by percutaneous drainage with follow-up imaging prior to drain removal were included in this single-center retrospective study. Data were collected retrospectively from the Amiens University hospital department of digestive surgery prospective colorectal database. According to the French law for single-center, retrospective study at the time of the study, no ethical approval was mandatory.

Study objective

Primary objective

The primary objective was to identify predictive factors of success of the first attempt of percutaneous drainage of postoperative collections.

Secondary objective

The secondary objective was to describe the natural history of percutaneous drainage of postoperative collections after colorectal surgery and the overall success rate of percutaneous drainage.

Inclusion/exclusion criteria

All postoperative collections following colorectal surgery requiring percutaneous drainage, regardless of the type of surgery (cancer, inflammatory bowel disease, non-specific inflammation, emergency surgery, elective surgery, with or without anastomosis, with or without stoma) were included in this study. Patients with anastomotic leaks were also included in the study. Patients who required exclusive antibiotic therapy or immediate reoperation were not included in the study.

Variables collected

- Epidemiological data: age, sex, body mass index (BMI), American Society of Anesthesiology (ASA) score, comorbidities.
- Surgical data: circumstances (elective, emergency) and type of operation.

- Collection-related criteria: time between surgery and diagnosis of the collection, initial imaging (type, size and number of collections), initial symptoms, initial laboratory parameters (C-reactive protein, leukocyte count).
- Natural history of percutaneous drainage: course of laboratory parameters (interval between percutaneous drainage and first follow-up assessment of CRP and leukocyte count, rate of regression of CRP and leukocyte count).

Definitions

Success of the first attempt of percutaneous drainage

Percutaneous drainage of collections was considered to be successful when a single percutaneous drainage was sufficient to ensure resolution of the collection without recurrence and without complications after drain removal. Patients in whom percutaneous drainage was not successful after the first attempt were excluded from analysis of the success rate of the first attempt of percutaneous drainage.

Overall success rate of percutaneous drainage

The overall success rate of percutaneous drainage was defined as resolution of the collection after one or several drainage procedures. This rate included patients who required several drainage procedures to achieve resolution of the collection.

Drain removal criteria

The decision to remove the drain was multifactorial (improvement in initial symptoms, afebrile, regression of inflammatory syndrome, flow < 20 mL/24 h, regression of the collection or complete resolution at follow-up imaging). Follow-up imaging was routinely performed for every patient with a radiological drain. In every case, the decision to remove the drain was validated by a staff surgeon.

Complete resolution of the collection

Complete resolution of the collection was defined radiologically as the absence of residual collection at follow-up imaging.

Percutaneous drainage procedure

Percutaneous drainage was performed by 3 experienced interventional radiologists using computed tomography or ultrasound guidance. The indication for percutaneous drainage was determined after consultation between radiologists and surgeons. The indication for percutaneous drainage was based on clinical (absence of septic shock, peritonitis) and radiological signs (size of the

collection (> 4 cm), accessibility of the collection to percutaneous drainage (determined by the radiologist)).

The patients were informed about the drainage procedure, and the risks and benefits of the procedure, and provided their oral consent prior to the procedure. All patients were hemodynamically stable. A preoperative clotting assessment was performed and any clotting disorders were corrected. Percutaneous drainage was performed in the interventional radiology room under strict aseptic conditions. Analgesic premedication and local anesthesia (lidocaine) associated with nitrous oxide sedation allowed percutaneous drainage to be performed under satisfactory conditions. The approach, drainage technique, number of drains, size, and path of the drain were decided according to the site and size of the collection, the appearance of the collected fluid, local conditions, and the operator's preference. Two techniques were used: the trocar technique or Seldinger technique, as previously described in the article by Robert et al. [12]. Various sizes of pigtail drains were used (7–12 French). Bacteriological samples were systematically obtained. When antibiotic therapy was prescribed, it was initially empiric (subsequently adapted to the results of antibiotic susceptibility testing) and was initiated immediately after the procedure.

Irrigations of 5 milliliters 3 times per day prevented drainage obstruction. The drain was monitored daily. Drain removal criteria were multifactorial (improvement of initial symptoms, afebrile, regression of inflammatory syndrome, flow < 20 mL/24 h, regression of collection or complete resolution at follow-up imaging). The decision was taken after consultation with the service practitioners. The duration of the antibiotic therapy was determined according to the results of the follow-up imaging.

Statistical analysis

Qualitative and quantitative variables were compared by Fisher's exact test or Chi-square test and Mann-Whitney test, respectively. Qualitative variables are expressed as number (%) and quantitative variables are expressed as mean (\pm standard deviation (SD)) or median (range). Univariate analysis was performed to identify predictive factors of complete resolution of the collection. Variables with a p value < 0.2 were included in a multivariate model with stepwise selection of variables. Variables with a $p \leq 0.1$ in multivariate logistic regression were considered to constitute risk factors and are presented together with their odds ratios (95% confidence interval). This model was characterized by sensitivity and specificity obtained from an ROC curve. A significant difference was defined as $p < 0.05$. Statistical analyses were performed with SAS software version 9.3 (Clary, NC, USA).

Results

Study population

Among the 1221 patients undergoing colorectal surgery during the study period, 53 patients (4.3%) required percutaneous drainage of a postoperative collection and were included in the present study. The characteristics of the study population are described in Table 1.

Natural history of percutaneous drainage

The indications for percutaneous drainage were abscess in 45 patients (85%), fistula in 6 patients (11%), and hematoma in 2 patients (4%). The median interval between initial surgery and diagnosis of postoperative collection was 8 days (range: 3–120 days). At the time of diagnosis, the mean CRP value was 137 mg/L (range: 25–253) and the mean leukocyte count was 14,344/mm³ (range: 11,500–22,430). After drainage, the first follow-up laboratory assessment (for the entire population) was performed after a median of 3 days (range: 1–15). At the first follow-up laboratory assessment, mean CRP was 71 mg/L (range: 9–220) and mean leukocyte count was 10,280/mm³ (range: 4400–19,000). All patients had follow-up imaging before drain removal except for one patient, who was urgently operated for peritonitis (failure of percutaneous drainage). Follow-up imaging consisted of ultrasound examination in 20 patients (37%) and CT scan in 33 patients (63%). The follow-up imaging was performed routinely in all cases, except for one patient operated in emergency. Eighteen patients (34%) had two or more follow-up imaging. Among the patients with failure of percutaneous drainage, the patients who had ultrasound as follow-up imaging had a 15% risk of failure compared to 42% for patient who had a CT scan ($p = 0.06$). The median interval between percutaneous drainage and drain removal was 7 days (range: 3–90 days). No complications related to percutaneous drainage were observed (Table 2).

Endpoint

Predictive factors of success of percutaneous drainage

Thirty-six patients (58%) had complete resolution of the collection at the first follow-up imaging. In univariate analysis, the patient with success of percutaneous drainage had a collection that was more often in the right iliac fossa (21% vs 5%, $p = 0.05$), a lower value of CRP at first follow-up (56 mg/L vs 94 mg/L, $p = 0.05$), a lower leukocytes rate at first follow-up (9001/mm³ vs 12,470/mm³, $p = 0.009$), and a higher regression rate of leukocytes at first follow-up (35% vs 9.5%, $p = 0.03$) (Table 1).

In multivariate analysis, post-appendectomy collections (OR = 3.19 (1.14–9.27), $p = 0.002$) and reduction

Table 1. Characteristics of the complete resolution group and the persistent collection group

	Success of first attempt of percutaneous drainage (<i>n</i> = 36)	Failure of first attempt of percutaneous drainage (<i>n</i> = 17)	<i>p</i>
Age (years)	54.3	60.1	0.81
Gender (M/F)	19/17	10/7	0.91
Mean ASA	2	2	0.20
Mean BMI (kg/m ²)	25.2	27.7	0.33
Comorbidities (% (<i>n</i>))			
Cardiovascular	27.7 (10)	29.4 (5)	0.95
Pulmonary	3 (1)	18 (3)	0.16
Renal	2.8 (1)	0 (0)	0.74
Diabetes	5.5 (2)	5.9 (1)	0.82
Cirrhosis	0 (0)	5.9 (1)	0.33
Emergency procedure (% (<i>n</i>))	80.5 (29)	52.9 (9)	0.08
Etiology			0.08
Appendicitis	23 (65)	6 (33)	
Cancer	8 (23)	10 (55)	
Diverticulitis	2 (6)	1 (6)	
IBD	2 (6)	1 (6)	
Type of operation (% (<i>n</i>))			0.08
Right colectomy	8.3 (3)	5.9 (1)	
Cecectomy	0 (0)	11.7 (2)	
Left colectomy	16.7 (6)	23.5 (4)	
Subtotal colectomy	2.8 (1)	17.6 (3)	
Hartmann procedure	2.8 (1)	5.9 (1)	
Proctectomy	2.8 (1)	5.9 (1)	
APE	2.8 (1)	11.7 (2)	
Appendectomy	63.9 (23)	17.6 (3)	
Type of collection (% (<i>n</i>))			
Abscess	88.9 (32)	76.5 (13)	0.07
Fistula	8.3 (3)	17.6 (3)	0.91
Hematoma	2.8 (1)	5.9 (1)	0.84
Radiological diagnosis (% (<i>n</i>))			
Ultrasound	41.7 (15)	29.4 (5)	0.43
CT	58.3 (21)	70.6 (12)	0.54
Type of collection			
Simple	77.8 (28)	64.7 (11)	0.37
Multilocular	22.2 (8)	35.3 (6)	0.37
Mean size ± range (cm)	7.1 ± 3.2	9.0 ± 4.1	0.11
Drain location (% (<i>n</i>))			
RIF/Right side	58.3 (21)	29.4 (5)	0.05
LIF/Left side	2.8 (1)	11.8 (2)	0.15
Pelvic	33.3 (12)	47.0 (8)	0.08
Supramesocolic	2.8 (1)	11.8 (2)	0.16

ASA American Society of Anesthesiologists, BMI body mass index

of the leukocyte count (OR = 3.22 (1.28–8.1), *p* = 0.013) were significantly associated with the success of percutaneous drainage. On ROC curve analysis, a 30% reduction of the leukocyte count (Se = 65%, Sp = 77%, AUC = 0.73, *p* = 0.03) was the most predictive factor of success of percutaneous drainage.

Overall success rate of percutaneous drainage

The overall success rate of percutaneous drainage was 90% (*n* = 48). Twelve patients required two percutaneous drainage procedures. Percutaneous drainage failed after two percutaneous drainage procedures in five patients. Three of these patients were reoperated and 2 were treated by endoscopic drainage.

Discussion

Percutaneous drainage of intra-abdominal collections has been shown to reduce morbidity and mortality compared to surgery, as studies of percutaneous drainage report success rates of up to 93% [13]. Khurum et al. analyzed the success rate of percutaneous drainage of postoperative collections following colorectal surgery [2]. The overall success rate of percutaneous drainage was 85%. The authors used the same definition of success after one or two percutaneous drainage procedures. The outcomes are very similar to the one found in our study (90% success rate). The drain removal time was not specified in Khurum et al. study. The authors reported 35% of incompletely drained collections at follow-up imaging, comparable to the rate observed in our study, as 32% of collections presented partial regression

Table 2. Natural history of percutaneous drainage

	Success of first attempt of percutaneous drainage (<i>n</i> = 36)	Failure of first attempt of percutaneous drainage (<i>n</i> = 17)	<i>p</i>
Interval between surgery and diagnosis of collection (days)*	15.5 (range: 3–100)	25.0 (range: 3–120)	0.35
Mean CRP at diagnosis (mg/L)	122 (range: 17–144)	168 (range: 9–220)	0.21
Mean leukocyte count at diagnosis (/mm ³)	14,177 (range: 4500–16,200)	14,688 (5200–17,350)	0.72
Follow-up laboratory assessment			
Time between diagnosis and first follow-up assessment (days)	2.9 (range: 1–15)	4.1 (range: 1–13)	0.35
Mean CRP at follow-up assessment (mg/L)	56 (range: 22–124)	94 (range: 28–201)	0.05
Mean leukocyte count at follow-up (/mm ³)	9001 (range: 4900–11,300)	12,470 (range: 5100–13,370)	0.009
Mean regression (%) of CRP at first follow-up assessment	56	38	0.93
Regression (%) of leukocyte count at first follow-up assessment	35	9.5	0.03
Time between drainage and drain removal (days)	10.1 (± 14.6)	10.6 (± 5.7)	0.85
Antibiotic therapy	100 (36)	100 (17)	1
Positive bacteriological sample	72.2 (26)	76.5 (13)	0.47

CRP C-reactive protein

*Imaging performed in the cases of clinical or biological abnormalities

or no regression. Another study published by Theisen et al. including 174 patients also showed similar results with a success rate of 85.6% [14].

The natural history of percutaneous drainage confirms that this technique constitutes a good alternative to surgery for the management of postoperative collections following colorectal surgery.

We also tried to identify factors allowing drain removal without follow-up imaging, based on the hypothesis that a patient drained for a simple postoperative collection, presenting improvement of postoperative clinical and laboratory parameters with decreased drain output may not require follow-up imaging before drain removal. The decision to remove a percutaneous drain could be based exclusively on clinical parameters (fever, pain, drain output < 20 mL/24 h) and laboratory parameters (CRP, leukocytes), which would shorten the length of stay (outpatient drain removal), decrease the cost of treatment and irradiation associated with follow-up computed tomography, decrease computed tomography room occupation times, and simplify patient care.

Several studies have tried to identify independent predictive factors of failure or success of percutaneous drainage for postoperative collections, but only concerned percutaneous drainage for postoperative collections after all types of surgery. The present study is the first to evaluate dynamic factors of success (evolution in time) of percutaneous drainage and give important data in the management of percutaneous drainage (success rate, number of drainage).

In a retrospective study of 81 patients with a 60% success after first drainage conducted by Kassi et al., multivariate analysis showed that a residual collection after first drainage (OR 0.296 95% CI (0.100–0.874), *p* = 0.02) was predictive of drainage failure [9]. Okita et al., in a series of 143 patients, found that the interval

between surgery and diagnosis of the collection (OR 1.248, 95% CI: 1.031–1.510; *p* = 0.02) and a solitary collection (OR 7.69, 95% CI: 1.899–31.13; *p* = 0.0042) were independent risk factors for the success of percutaneous drainage [10]. Finally, Benoist et al., in a series of 73 patients, found that the size of the collection (< 5 cm) (OR 7.45, 95% CI: 3.01–13.88; *p* = 0.01) and the absence of antibiotic therapy (3.82, 95% CI: 1.78–8.21; *p* = 0.037) were risk factors for failure of percutaneous drainage [11].

The results of this study show that clinical and laboratory signs might be sufficient to indicate removal of a percutaneous drain for a post-appendectomy collection on day 3, in the presence of satisfactory clinical parameters (regression of fever and pain, drain output < 20 cc/24 h), with sensitivity, specificity, and area under the curve of 86.1%, 42.1%, and 0.82, respectively. This is the first study to address this specific point.

The results of this study are consistent with those the study by Theisen et al., which analyzed the overall success rate according to the site of the collection and reported a 93% success rate for collections located in the right iliac fossa [14], as confirmed in our study.

Rotman et al., in a series of 144 cases of drainage of intra-abdominal collections, investigated the effect of density and size of the collection on the size of the drain and the duration of drainage. They reported a predictable additional drainage time of 16 days for collections > 200 mL compared to collections < 50 mL. Eighty-five percent of drains were changed at least once mainly because of obstruction. No predictive factor (collection size, drain size, and collection density) of drain occlusion was identified. No conclusions can be drawn concerning the impact of the viscosity of drainage fluid on the success of drainage, as the primary endpoint in this study was the duration of drainage and not the overall success rate [15].

Our study shows that the management of subcutaneous drainage of postoperative collections can be simplified in selected patients.

This study comprises several biases, mainly the retrospective nature of the study and the small sample size, but similar to that observed in other studies on this subject. It should also be noted that the interval between drainage and control of the collection/drain removal was based on the evolution on patients symptoms and decision of the clinician without robust criteria. It might induce a bias. Another limitation is that due to the number of patients, it was mandatory to limit the number of analysis of risk factors to limit the increase of the α risk.

Conclusion

Percutaneous drainage is a good alternative to surgery for the management of postoperative collections after colorectal surgery. Follow-up imaging prior to drain removal might not be necessary in patients drained for post-appendectomy collections and/or with a greater than 30% reduction of the leukocyte at the first follow-up assessment.

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