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The role of CT-guided percutaneous drainage of loculated air collections: an institutional experience

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Abstract

Objective: The purpose of this study is to describe our experience with the role of CT-guided percutaneous drainage of loculated intra-abdominal collections consisting entirely of gas.
Materials and methods: An IRB-approved retrospective study analyzing patients with air-only intra-abdominal collections over an 8-year period was undertaken. Seven patients referred for percutaneous drainage were included. Size of collections, subsequent development of fluid, and microbiological yield were determined. Clinical outcome was also analyzed.
Results: Out of 2835 patients referred for percutaneous drainage between 2004 and 2012, seven patients (5M, 2F; average age 63, range 54–85) met criteria for inclusion with CT showing air-only collections. Percutaneous drain placement (five 8 Fr, one 10 Fr, and one 12 Fr) using Seldinger technique was performed. Four patients (57%) had recently undergone surgery (2 Whipple, 1 colectomy, 1 hepatic resection) while two (29%) had a remote surgery (1 abdominoperineal resection, 1 sigmoidectomy). Despite the lack of detectable fluid on the original CT, 6 patients (86%) had air and fluid aspirated at drainage, 5 (83%) of the aspirates developed positive microbacterial cultures. Four patients (57%) presented with fever at the time of the initial scan, all of whom had positive cultures from aspirated fluid. Four patients (57%) had leukocytosis, all of whom had positive cultures from aspirated fluid.
Conclusions: Although relatively rare in occurrence, patients with air-only intra-abdominal collections with signs of infection should be considered for percutaneous management similar to that of conventional infected fluid collections. Although fluid is not visible on CT, these collections can produce fluid that contains organisms.

Key words: Air collection—Percutaneous drainage—CT

The role of image-guided percutaneous drainage of intra-abdominal fluid collections has been well established and is met with high technical and clinical success [1, 2]. Percutaneous drainage offers a minimally invasive temporizing first-line or alternative treatment option compared to surgical interventions [3, 4]. Specifically, percutaneous catheter drainage is routinely performed prior to definitive surgical resection in various cases involving acute inflammatory processes (i.e., ruptured appendicitis, complicated diverticulitis, etc.), often times allowing the surgery to be performed on an elective basis [2, 5–7]. Finally, image-guided drainage serves an important role in the management of post-operative abscesses, especially in cases of suspected anastomotic leaks where drainage can allow healing of the anastomosis thereby avoiding the need for surgical intervention in the short term [1, 8–11].

Guidelines in patient selection, preparation, and techniques of percutaneous abscess drainage have also been well established [11–16]. Radiologic features typical of infected fluid collections (e.g., peripheral enhancing rind, air-fluid level, gas bubbles, etc.) along with supportive clinical findings and suspicion usually allow relatively easy identification of those collections requiring percutaneous intervention [17]. While most drainable collections typically present as fluid only or air-fluid collections, we have encountered rare occurrences of discrete air-only collections. These collections

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are typically in the immediate post-operative setting and are different from that expected with post-operative free air or pneumoperitoneum (Fig. 1). To our knowledge, there is no data in the literature regarding the role of percutaneous drainage of such collections. The purpose of this study is to describe our experience with the role of CT-guided drainage of air-only collections.

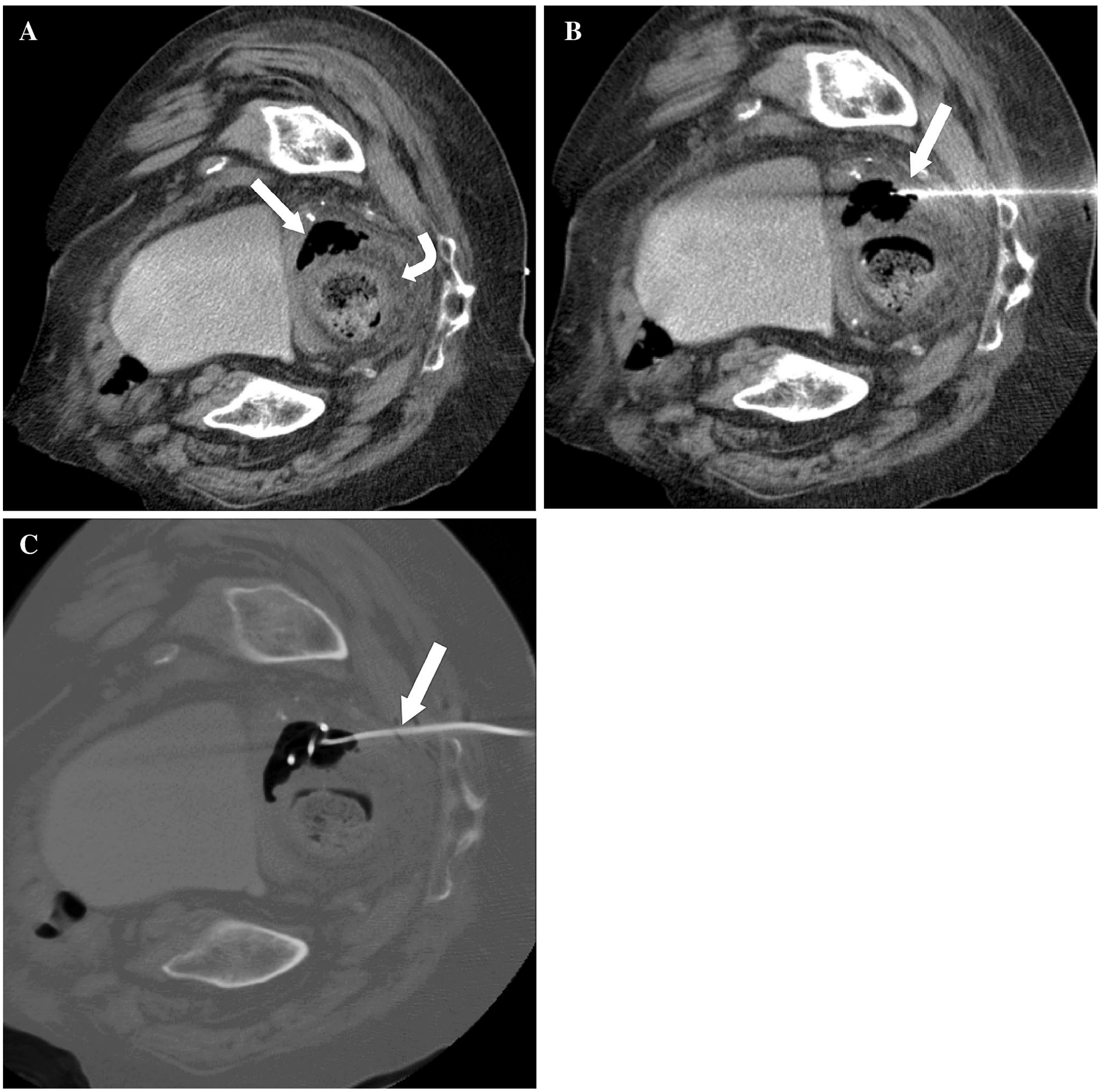

Fig. 1. 85-year-old female (patient #1) with fever, leukocytosis, and abdominal pain. **A** Contrast-enhanced CT shows a loculated perirectal air-only collection (*straight arrow*). Inflammatory changes of the rectum are present with wall thickening and perirectal fat stranding (*curved arrow*). **B** Patient underwent percutaneous drainage of perirectal air collection. CT through the pelvis shows an 18-gauge trocar needle (*arrow)* placed in the collection in preparation for subsequent catheter placement. **C** CT shows 8 Fr percutaneous catheter (*arrow*) placed in a transgluteal approach with the pigtail formed in the collection.

Materials and methods

Our institutional review board approved this retrospective, HIPAA-compliant consent-exempt study.

Subjects

Using a searchable electronic medical record database, we retrospectively identified 2835 patients who presented to our department for collections requiring CT-guided percutaneous drainage performed between January 2004 through December 2012. Images were reviewed to determine the nature of the collections. Patients were included if a diagnostic multi-detector computed tomography (MDCT) of the abdomen and pelvis showed a discrete air-only collection and subsequently underwent percutaneous drain placement. Patients with discrete predominantly air-containing fluid collections or free air were excluded. Patients with predominantly air-containing air-fluid collections or collections with subtle fluid component were excluded. A total of seven patients (0.2%) met the criteria and were included in the study.

For each patient, the electronic medical record (E-browser 7.002, Pegasus Imaging) was reviewed by two of the authors to record the clinical and surgical history, presence of fever and leukocytosis, and location and size of the collections. Whether or not fluid was aspirated at the time of the drainage or subsequently after the drain was placed was noted in addition to subsequent culture growth from the aspirate. Catheter size and insertion techniques were also recorded.

Drainage procedure

After patients were referred by surgical services for percutaneous intervention, an informed written consent was obtained from each patient as part of routine practice. All patients underwent image-guided percutaneous drain placement using a 16-detector MDCT scanner (Lightspeed 16, General Electric Healthcare, Milwaukee, WI). CT-guided drainage was performed by an attending radiologist with the assistance of a fellow or resident. Percutaneous drainage rather than simple aspiration was performed under the assumption that some of the air collections were due to anastomotic leaks while others were felt to be a source of infection. Thus, a drain was placed to temporize the patient and allow the anastomosis to heal or to serve as source control for those patients presumed to have an infected collection. The drain would also treat any re-accumulation of air or fluid that might otherwise occur after a simple aspiration. Patients were placed in a supine or right lateral decubitus position on the CT table and access to the collection was achieved with an 18 G trocar needle (Cook Medical, Bloomington, IN). A pigtail drainage catheter was placed in the collection using a Seldinger technique. Catheter size was determined at the time of the procedure and at the discretion of the attending radiologist taking into account factors of type of collection, size, location, and general preference of the radiologist performing the procedure. All but two patients underwent drain placement with an 8 Fr catheter (Flexima APDL, Boston Scientific Natick, MA) due to the lack of fluid detected on the preceding diagnostic CT. Two patients received 10 and 12 Fr drains at the discretion of the radiologist. Before connecting the catheters to suction bulbs (Davol, BARD, Warwick, RI), a 20-cc syringe was attached to the catheter for aspirations. Any yielded aspirate was sent for laboratory analysis. Because, a majority of patients yielded fluid aspirate, standard catheter care of flush with 10 cc of 0.9% saline three times per day by inpatient nursing was implemented to maintain patency.

Data collection

Two of the authors retrospectively analyzed the electronic medical record of each of the seven patients to collect variables. Specifically, pre-procedure data including patient's demographics, presence or absence of fever and leukocytosis, and surgical history was collected. Procedure details from our picture archiving and communication system (PACS) were used to collect details regarding the air collections, including size and location. Procedure details, such as patient positioning, number and size of catheters used, and amount and type of fluid aspirated from the catheter were also collected from PACS. Finally, the electronic medical record was used to record microbiological results from fluid aspirates as well as the patient's clinical course.

Outcome

The electronic medical records for each patient were searched to determine outcomes for each patient using inpatient progress notes and discharge summaries. A clinical outcome was considered successful if the patient did not require same stay operative management of their collection after percutaneous drain placement and were subsequently discharged from the hospital. Clinical failure was defined as worsening clinical status or increasing size or number of collections requiring either re-drainage or surgical management during the same hospital stay.

Technical success was defined as successful placement of a percutaneous drain within the air collection confirmed on CT. Technical failure was defined as inability to place a drain by the operator, or the occurrence of peri- or immediate post-procedural related complications.

Table 1. Patient demographics and clinical data

Patient	Age (years)	Sex	History	Duration between surgery and drain	WBC count	Fever
1	85	F	Fever, leukocytosis, proctitis	N/A	25	Y
2	54	F	APR	9 years	22	Y
3	63	M	Ileocecectomy, small bowel resection, and lysis of adhesions	8 days	11	Y
4	54	M	Hepatic resection	6 days	12	N
5	66	M	Whipple	10 days	9	Y
6	54	M	Whipple	115 days	3	N
7	57	M	Sigmoidectomy	4 years	5	N

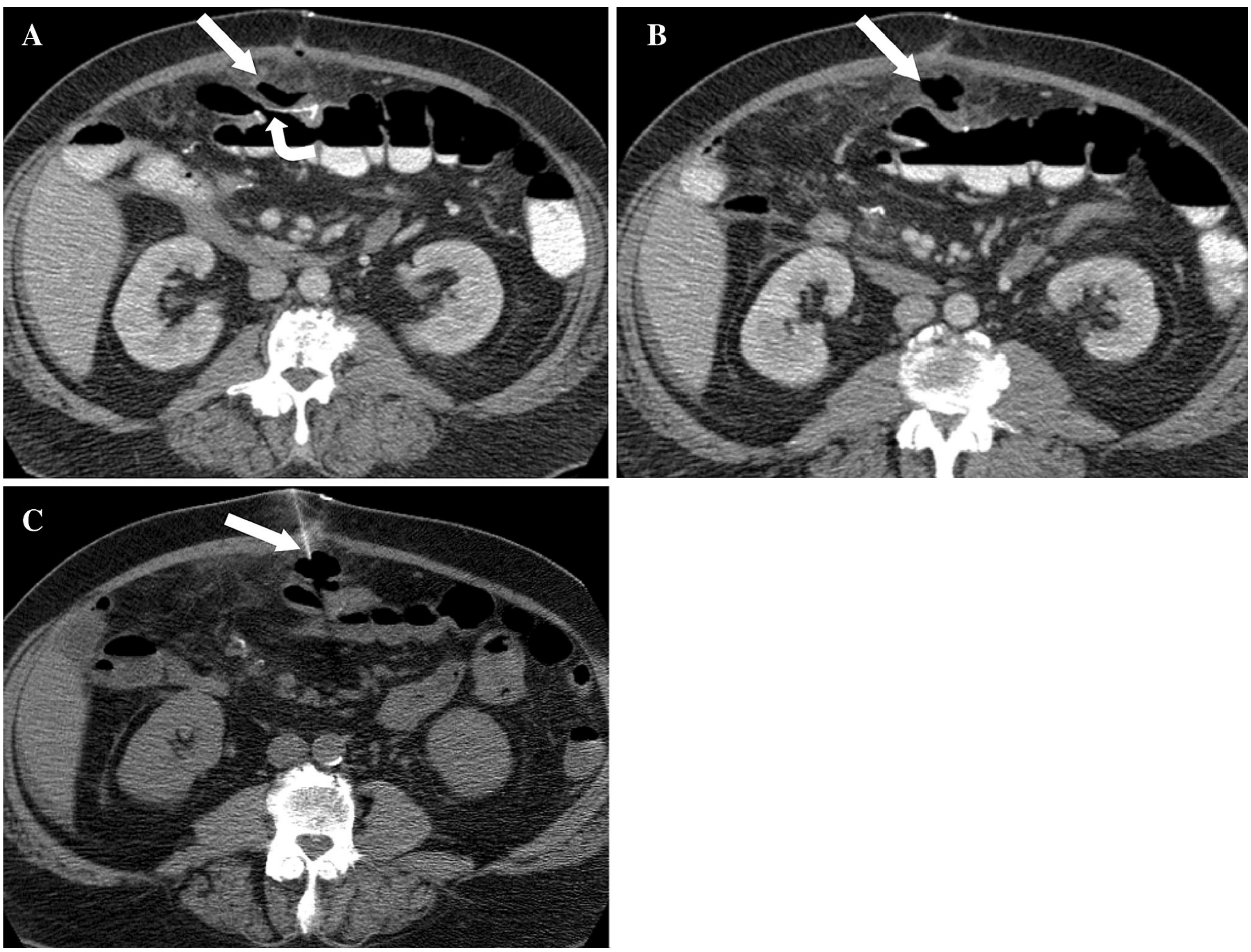

Fig. 2. A 63-year-old male (patient #3) status post ileocecectomy for colon carcinoma. **A** Contrast-enhanced CT shows the cranial component of a bi-lobed loculated air-only collection (*straight arrow*) adjacent to the enterocolonic anastomosis (*curved arrow*). **B** Contrast-enhanced CT shows the caudal component of a bi-lobed loculated air-only collection (*arrow*). **C** CT shows an 18-gauge trocar needle (*arrow*) tip within a loculated peri-anastomotic air collection in preparation for catheter placement.

Results

Clinical data

A total of seven patients (5 male, 2 female; average age 63 years, range 54–85) presented for percutaneous management of air-only collections (Table 1). Four patients (57%) had recently undergone intra-abdominal surgery with a mean duration time between surgery and drain placement of 34.8 days. Three of these patients presented with post-operative air-only collections and were referred from the surgical team for presumed bowel anastomotic leak (Fig. 2) despite one patient (#6) not exhibiting fever or leukocytosis at the time of request. One (patient #4) of these four patients presented with an air collection con-

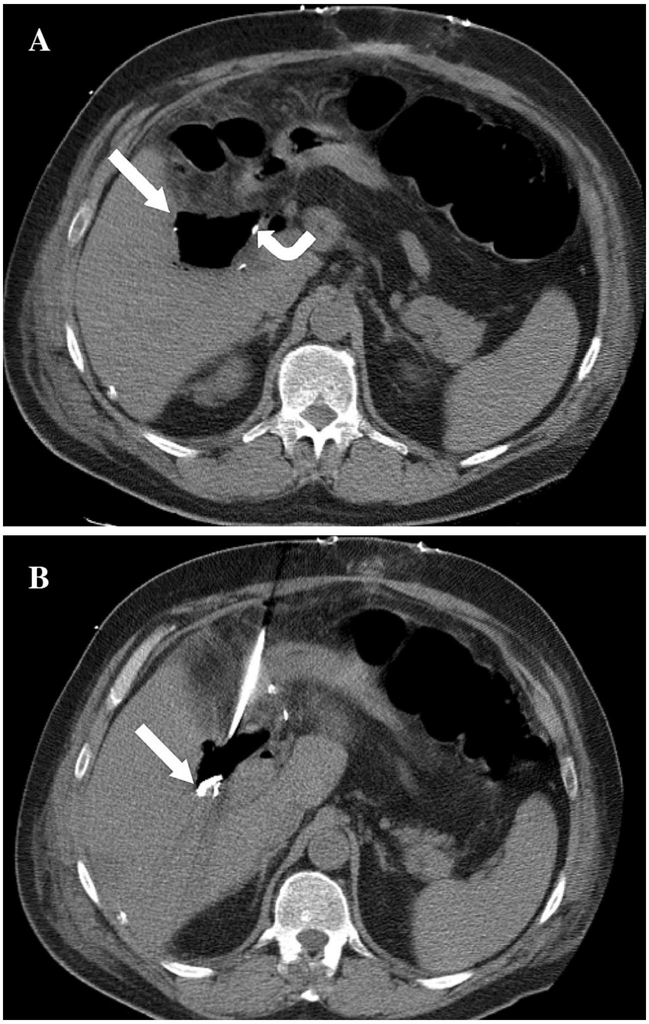

Fig. 3. **A** 54-year-old male (#4) with a history of metastatic rectal cancer status post-partial hepatectomy of hepatic metastasis. Unenhanced CT shows loculated air collection (*straight arrow*) in the hepatectomy bed (*curved arrow* points to one staple marker). **B** 54-year-old male (#4) with a history of metastatic rectal cancer status post-partial hepatectomy of hepatic metastasis. Unenhanced CT image shows pigtail drain (*arrow)* within the loculated air collection.

cerning for an infected post-operative collection after hepatic resection and was referred for percutaneous drainage (Fig. 3).

Two patients had remote colorectal surgeries [abdominoperineal resection (APR) and sigmoidectomy 9 and 4 years prior to drainage, respectively]. Of these two patients, one had undergone radiation treatment as part of malignancy treatment and had a chronic perianal wound presumed to be secondary to radiation (Fig. 4). The other patient (#7) presented with pneumatosis intestinalis on CT with an adjacent right upper quadrant loculated air collection. The surgical team requested percutaneous drainage as it was felt that this would

Fig. 4. 54-year-old female (patient #2) with a remote history of APR for anal carcinoma status post chemoradiation treatment. Contrast-enhanced CT shows loculated presacral air collection (*straight arrow*) with marked presacral soft tissue thickening (*curved arrow*). Images more caudally demonstrated fistulous communication to the posterior skin surface.

evolve into a typical abscess despite no fever or leukocytosis at the time of the request (Fig. 5). The final patient had no prior intra-abdominal surgery and presented with fever, leukocytosis, and CT findings of proctitis with an adjacent air-only collection (Fig. 1).

Collections and drainage

All seven patients underwent percutaneous drain placement with an average duration between the time of initial scan and drainage of 1.9 days. Technical and clinical success was achieved in all patients with five 8 Fr, one 10 Fr, and one 12 Fr catheter placement. Location and size of collections are summarized in Table 2. Although limited CT images take during drain placement showed no demonstrable fluid, fluid was aspirated from drains at the time of drain placement in six patients (86%). Of these six patients, five (83%) patients had positive microbiologic culture growth. All patients with leukocytosis (white blood cell count $>10 \times 10^3/mm^3$) at presentation (100%) had positive cultures from the aspirated fluid. Similarly, all four patients who presented with fever (temperature >37.5 °C) had positive bacterial cultures from the aspirated fluid. None of the patients required repeat percutaneous drainage or upsizing or manipulation of the original catheter. All patients underwent a follow-up CT of the abdomen and pelvis after drain placement, with an average interval of 10.7 days. Collections had decreased in size in five patients, resolved in one patient (#6), and did not significantly change in another (#2). Four (#2, 5, 6, 7) of the seven patients did not have documentation in the electronic medical record of when the drains were removed by the surgical team, either due to outpatient surgical

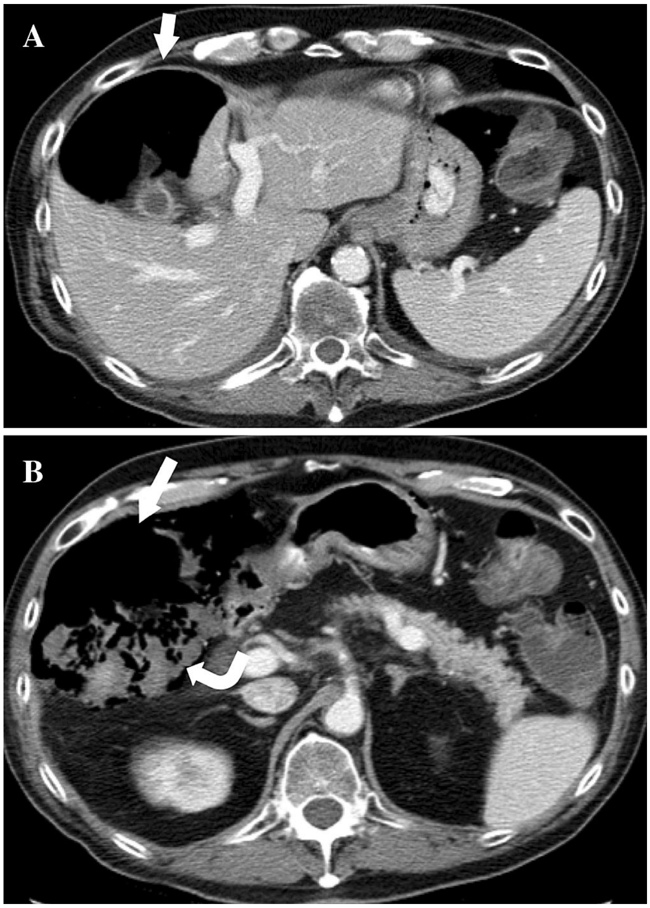

Fig. 5. **A** 57-year-old male (patient #7) with a remote history of sigmoidectomy for colon carcinoma presented with benign intestinal pneumatosis. Contrast-enhanced CT shows a loculated air collection (*arrow*) within the right upper abdominal quadrant. **B** 57-year-old male (patient #7) with a remote history of sigmoidectomy for colon carcinoma presented with intestinal pneumatosis. Contrast-enhanced CT shows a loculated air collection (*arrow*) within the right upper abdominal quadrant adjacent to benign intestinal pneumatosis of the hepatic flexure (*curved arrow*).

care outside of our institution or lack of documentation of the date of drain removal. The remaining three patients had drains in place on an average of 11 days.

Discussion

The CT appearances of intra-abdominal abscesses are well known, commonly manifesting as discrete low attenuation fluid or air-fluid collections with or without a rind of peripheral enhancement [17, 18]. Evolution of abscesses on follow-up imaging with interval changes in the size of the fluid or air component are also commonly encountered in routine practice.

Although various etiologies for intra-abdominal abscesses exist, perhaps the most commonly encountered extra-visceral intra-peritoneal abscesses occur in the setting of inflammatory bowel disease or in the post-operative state. Post-operative anastomotic leaks after bowel resection are reported to occur in up to 40% of patients and can be associated with significant morbidity and mortality [18–21]. Percutaneous drainage catheter placement is routinely used to temporize patients either prior to definitive surgery or to allow small anastomotic leaks to heal [2, 22]. In our study, four patients had recently undergone intra-abdominal surgery and the air collections in three patients were thought to represent a manifestation of anastomotic leaks given their proximity to the bowel anastomoses; the fourth patient had an air collection felt to represent a frank infected post-operative collection. In the other two remote post-operative patients, we were asked to drain air collections that were felt to be the source of patient's fever and leukocytosis or concerning for possible future evolution into an infected collection if not treated percutaneously. To our surprise, we found that, despite the absence of fluid on initial CT, almost all of the loculated air collections produced fluid at aspiration. In patients with clinical symptoms consistent with infection, fluid aspirated during the procedure yielded infectious organisms on culture. CT drainage of these air collections provided clinical information for appropriate antibiotic therapy and decreased the necessity for surgical intervention.

In our series, all procedures were technically and clinically successful and no patient required subsequent surgical intervention. The high success rates despite the appearance of these collections is in keeping with the fact that most CT imaging features of abscesses (e.g., air-fluid

Table 2. Collection and drainage characteristics

Patient	Location of collection	Size of collection (cm)	Technique	Size of drain (s)	Fluid aspirate	Culture growth
1	Perirectal	4.0 × 2.7	Seldinger	8 Fr	Y	Mixed gram positive and negatives, including anaerobes
2	Presacral	4.1 × 2.7	Seldinger	8 Fr	Y	Gram positives including yeast
3	Intraperitoneal, adjacent to anastomosis	Bi-lobed (3.0 × 2.1 and 2.8 × 1.8)	Seldinger	8 Fr	Y	Mixed gram positive and negatives, including anaerobes and *E. coli*
4	Periportal	6.8 × 4.4	Seldinger	10 Fr	Y	Mixed gram positive and negatives, including *C. freundii* and yeast
5	Adjacent to hepaticojejunostomy and pancreaticojejunostomy	10.0 × 4.2	Seldinger	12 Fr	Y	*P. aeruginosa, E. cloacae,* yeast
6	Adjacent to hepaticojejunostomy	9.1 × 2.8	Seldinger	8 Fr	N	No growth
7	Intraperitoneal, right upper quadrant	9.7 × 5.1	Seldinger	8 Fr	Y	No growth

level, peripheral rind, etc.), other than size (3 cm) have yet to be shown as reliable predictors of successful drainage outcome [13, 17, 23]. Most of the collections were drained with small caliber catheters and no patients required additional percutaneous drainage or catheter manipulation. The success rate with smaller lumen catheters suggests that air-only collections do not contain high viscosity fluid that might otherwise fail with smaller lumen drainage catheters. The use of smaller catheters is in keeping with the range of sizes commonly used in our practice (8–14 Fr) as well as those across other practices [24].

All of the patients in our series presented with discrete air-only collections without evidence of even subtle dependent fluid in the collections on diagnostic CTs or on limited CT images obtained during drainage. Despite this appearance on CT, almost 90% of the patients had fluid aspirated upon placement of drain. Non post-operative intra-abdominal infected collections presenting in this way are unusual and, to our knowledge, have not been reported. In the post-operative setting, anastomotic leaks are most reliably identified by presence of extraluminal contrast. An air-fluid collection with disproportionately higher volume of air is also known to be suggestive of an anastomotic leak [18, 25]. One study has showed the presence of peri-anastomotic loculated air in approximately 30% of patients with bowel anastomoses requiring intervention but found almost an equal number (28%) in patients without a clinically significant anastomotic leak [20]. While this feature was shown not to be a significantly reliable predictor of patients with anastomotic leaks that required intervention, loculated air was found in greater proportion overall in all patients with a bowel anastomotic leak versus the control group [20]. Due to the small size of our study group in our series and lack of control group, we were not able to determine the relative incidence and significance of peri-anastomotic discrete air collections.

The presence of air in a collection from an anastomotic leak is intuitive, representing escaped extra-luminal air from bowel through a small defect or site of dehiscence. A similar inference of the mechanism of development of the air collection can be made in the cases of remote surgery as this likely represents a microperforation from bowel inflammation. Of significance, leaks beyond 6 months in patients with colorectal surgery can present with presacral air [18]. Another contributor to the CT presentation of our patients may be explained by the evolution of air-fluid collections. It is conceivable that patients were imaged at a time point when either the fluid component had decreased or not yet formed. The latter explanation is more likely as six of our patients had a small amount of fluid aspirated at the time of drainage. One study has shown that anastomotic leaks from bowel surgery after 6 months usually evolve with a decrease in the amount of air in over half of the patients [25].

There were several limitations to our study. First, our study was a retrospective study with a small number of patients; we feel this is reflective of the relatively rare appearance of air-only collections. Because of the small size of our study group, it is difficult to draw conclusions regarding whether or not certain imaging features in these patients allow reliable predictability of technical and clinical success of percutaneous drainage. Another limitation also imposed by our small cohort is the lack of a control group to determine the course of patients with discrete air collections who do not undergo percutaneous drainage. We recognize that our referring clinicians have a low threshold to refer patients for percutaneous intervention and we understand this may not be common practice. However, we have described our experience with patients with infected collections presenting as discrete air-only collections so as to guide interventionalists should they experience such rare cases.

In conclusion, patients who present with discrete air-only collections should be considered for percutaneous drainage, especially in the post-operative state and in the presence of fever and/or leukocytosis. Although fluid may not perceptible on CT, these collections can contain small amount of infected fluid.

Financial disclosures None.

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