Diverticular abscess, pelvic and other intra-abdominal abscesses

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Abstract

Intra-abdominal abscesses are a common surgical problem, occurring primarily in association with a variety of perforating or suppurative intra-abdominal visceral diseases or secondary to postoperative complications, including anastomotic dehiscence. Early diagnosis and recognition of associated pathology, based on clinical assessment and appropriate investigation, including accurate cross-sectional imaging and interpretation, are essential for the planning of treatment and eradication of sepsis. Safe image-guided percutaneous drainage and administration of appropriate antibiotics is the gold standard, with surgical intervention mostly required for delayed definitive treatment after resolution of sepsis, after failed conservative treatment or in the emergency setting for an acutely unwell patient. Specific considerations for the diagnosis and management of the more commonly encountered pelvic and intra-abdominal abscesses, particularly diverticular abscesses, are further discussed in this article.

Keywords Appendicitis; appendix mass; colorectal cancer; Crohn's disease; diverticulitis; percutaneous drainage; psoas abscess; subphrenic

Introduction and classification

An abscess is a localized collection of pus, buried in tissues, organs or confined spaces. Intra-abdominal abscesses (IAA) are among the most common causes of infectious morbidity in the surgical patient. They may occur as sequelae of primary inflammatory processes, such as diverticulitis, appendicitis or Crohn's disease, or as a complication of abdominal surgery. Inadequate peritoneal lavage at laparotomy or laparoscopy for peritonitis from any cause, with less than meticulous washout of all spaces including between bowel loops, runs the risk of abscess formation. If not promptly controlled, IAA risk further morbidity and mortality. IAA may be classified anatomically and practically as visceral (e.g. hepatic or splenic), non-visceral (e.g. subphrenic or pelvic), intra-peritoneal or retroperitoneal (Table 1). Non-visceral abscesses arise following the resolution of peritonitis in which a persistent loculated area of infection and suppuration is 'walled off'. Visceral abscesses are usually caused by haematogenous or lymphatic dissemination of bacteria. Retroperitoneal abscesses may result from intestinal perforation as well as by haematogenous or lymphatic spread. There are important distinctions between postoperative and spontaneous abscesses not associated with previous surgery, and in simple and complex (e.g. multiple, multiloculated, associated with tissue necrosis, enteric communication or tumour) abscesses, which require more aggressive therapy and carry a poorer prognosis.

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Bacteriology

The bacteriology of IAA is usually polymicrobial. Abscesses that develop in the aftermath of secondary peritonitis possess synergistic aerobic and anaerobic flora. Endotoxin-generating facultative anaerobes, such as *Escherichia coli*, are responsible for the phase of acute peritonitis, and the obligate anaerobes, such as *Bacteroides fragilis*, are responsible for late abscess formation. Similarly, visceral and retroperitoneal abscesses are polymicrobial, containing aerobic, anaerobic, Gram-negative and Gram-positive bacteria. Primary abscesses are often monobacterial, predominantly staphylococcal. Postoperative abscesses are often characterized by the flora typical of tertiary peritonitis, representing super-infection with yeasts and other commensals. The low virulence of these organisms reflects the global immunodepression of the affected patients.

Diverticular abscess

The pathological mechanisms leading to diverticula formation remain unclear but a complex interaction between diet, gut microbiome, genetic factors, colonic motility and structure over time is likely. Alterations in colonic muscle properties, collagen metabolism and in the interactions of the extracellular matrix components may play a role in remodelling of the gut wall in diverticular disease.

Acute diverticulitis (AD) is a common cause of acute abdominal pain. Complicated AD refers to AD with abscess formation, perforation or fistula formation. There is a wide spectrum of symptoms that can arise in AD. Seasonal variation in hospital admissions for diverticulitis has been shown, and lower socioeconomic status is more likely to be associated with increased presentations with severe disease.

Complicated AD, occurring in 20% of patients with diverticulitis, is most usefully classified using the modified Hinchey classification. This categorizes patients with AD into four major categories (I, II, III, IV) and two additional subcategories (Ia and Ib), depending on the severity of disease (Table 2). Other classification systems have been described for AD, some based on CT or intraoperative findings: these include the American Association for the Surgery of Trauma (AAST), modified Neff, Ambrosetti, Kohler, Hansen/Stock, Siewart, Boostrom, and the Cleveland Clinic diverticular disease propensity score.

The diagnostic accuracy of clinical evaluation for AD is low, but a symptom triad of left lower quadrant pain, fever and

absence of vomiting is suggestive of sigmoid diverticulitis. Urinalysis and pregnancy test may be helpful in excluding other diagnoses that can mimic the presentation of AD, such as urinary tract infections, ureteric calculi and ectopic pregnancy. Laboratory tests should include full blood count, renal function, amylase and C-reactive protein in (CRP). Several clinical decision-making tools developed to establish the diagnosis of acute diverticulitis include serum CRP >50 mg/L as an independent predictor of AD. CRP can be used as an indicator for the presence of complications in AD, patients with a CRP >150 mg/L having an increased risk of complicated AD. A CRP >200 mg/L is a strong indicator of perforation. CRP has both diagnostic and prognostic value for patients with AD, and a CRP value higher than 150 mg/L is associated with an increased risk of postoperative mortality. Leucocytosis is also related to complicated AD and risk of surgical intervention. However, it has been demonstrated that patients with fever and leucocytosis that resolves within the first 48 hours of initiating treatment have improved outcomes. Uncomplicated AD or Hinchey stage I disease can be treated on an outpatient basis, with a 6%–10% risk of readmission, very low rates of complications and opportunity for substantial financial savings. Patient selection is key. In patients selected for outpatient management, any imaged abscess should be <3 cm, there should be no signs of sepsis, the patient should be able to tolerate oral intake and have an adequate social network. Patients should be admitted if other risk factors are present such as age >65 years, significant comorbidities, or immunosuppression.

Early CT imaging should be undertaken in suspected cases of AD in order to confirm the diagnosis and to plan therapy, including abscess drainage. CT and ultrasound (US) have similar sensitivity and specificity for uncomplicated AD, US avoiding the risk associated with ionizing radiation. Severe abdominal pain, obesity and obscuring bowel gas can preclude satisfactory US examination and so the use of US is limited in complicated AD and is operator-dependent. Other benefits of CT include identification of alternative diagnoses and extra-colonic abnormalities. CT findings in diverticulitis include colonic wall thickening, pericolic inflammation (phlegmon or fat stranding), abscess or extraluminal gas or contrast (Figure 1). Water-soluble contrast enema examination is inferior to CT in detecting complicated AD, particularly associated abscess, and has fallen out of use. MRI has high sensitivity and specificity for diagnosing AD but availability and cost limit its use. Patients with complicated AD should be administered broad-spectrum antibiotics, but regular clinical re-evaluation must be undertaken to determine success or failure of treatment. There is no evidence mandating the use of routine antibiotics in uncomplicated AD. Conservative treatment strategy without antibiotics in patients with uncomplicated AD has proven to be safe, with long-term outcomes in terms of recurrence, complications and need for surgery being similar to those treated with antibiotics and so there should at least be a selective rather than routine approach to use of antibiotics in uncomplicated AD. A CRP level >170 mg/L is a risk factor for non-antibiotic treatment failure and the decision for non-operative therapy in a patient with complicated AD must be based on the patient's physiological state and associated comorbidities. The majority of patients with complicated AD can be treated conservatively with antibiotics, including cases with abscess and pericolic extraluminal air. Isolated peri-colic extraluminal gas – defined as free gas more than 5 cm from the site of inflammation – is found in up to 15% of patients with complicated AD. Some 6% of patients with AD and isolated peri-colic extra-luminal air will need emergency surgery, and 30-day mortality rate is 2%. Simultaneous abscess and perforation occur in around 18% of patients. In patients with free gas, and in the absence of severe peritonitis or sepsis, up to one-third may be successfully managed non-operatively with antibiotics. Following successful non-operative management of AD, the proportion of patients having at least one subsequent readmission is 8%–21%. Readmission occurs within 1 year in 55%, the risk decreasing with time thereafter. Of those readmitted, approximately 22%, or between 1.8% and 8.3% of all patients, will subsequently undergo surgery.

Pelvic abscesses should be assessed by an experienced interventional radiologist and should be drained percutaneously if a safe route into the abscess can be negotiated. In Hinchey II AD, patients with abscesses smaller than 3 cm in size are treated with antibiotics alone. This is also likely true for abscesses sized 3–4 cm. However, when technically feasible, patients with abscesses larger than 4 cm should be managed with CT-guided abscess drainage and systemic antibiotic therapy. Location of the abscess can predict response to antibiotic therapy alone, mesocolic abscesses being more likely than pelvic or intra-abdominal abscesses to respond. Reported failure rates for percutaneous diverticular abscess drainage – when there are signs of continuing sepsis, abscess or fistula within 4 weeks – range from 15% to 30%. Imaging before percutaneous drain removal is associated with reduced risk of recurrence.

Transabdominal and transgluteal routes of drainage are most commonly used. The transgluteal route runs the risk of sciatic nerve injury. Colocutaneous fistula may result from either of these routes; indeed, pelvic sepsis may penetrate through the sciatic notch (Figure 2). The transvaginal drainage of pelvic abscess may be the safest route in some females. This may be

Classification of intra-abdominal abscesses

Classification	Examples
Visceral vs non-visceral	Hepatic vs subphrenic
Primary vs secondary	Splenic vs appendiceal
Spontaneous vs postoperative	Diverticular vs peri-anastomotic
Intra-peritoneal vs retroperitoneal	Tubo-ovarian vs psoas
Simple vs complex	Complex: • multiple • multiloculated • communication with bowel (anastomotic leak) • associated with necrotic tissue (pancreatic) • associated with cancer
Anatomical	Subphrenic, sub-hepatic, lesser sac, paracolic, pelvic, interloop, perinephric, psoas

Table 1

Modified Hinchey classification of complicated AD

Stage	Description
Stage Ia	Confined pericolic inflammation – phlegmon
Stage Ib	Confined pericolic abscess (within sigmoid mesocolon)
Stage IIa	Pelvic, distant intra-abdominal or intraperitoneal abscess amenable to percutaneous drainage
Stage IIb	Complex abscess associated with fistula
Stage III	Generalized purulent peritonitis
Stage IV	Faecal peritonitis

Table 2

achieved with the help of transvaginal ultrasound and aspiration or surgical incision through the pouch of Douglas into the pelvis in a female who has not previously undergone hysterectomy. Fistulation of the offending sigmoid loop into the vagina creating a colovaginal fistula is a potential complication of this drainage route.

Laparoscopic lavage for diverticular abscesses is not currently recommended but may be an acceptable alternative to avoid major resection if percutaneous drainage is impossible or ineffective, provided its limitations are communicated to patients. Decision making for surgical intervention in cases of complicated AD hinge upon good clinical judgement, taking into account the patient's clinical status, comorbidity, immunosuppression, signs of peritonitis and/or sepsis.

The optimal management of Hinchey III AD has been the focus of much debate. Studies of laparoscopic lavage (LL) in Hinchey III AD without visible perforation have shown that LL is a safe alternative to resection but outcomes from studies show a three-times greater chance of ongoing intra-peritoneal sepsis with LL than with open resectional surgery, with significantly increased rates of postoperative intra-abdominal abscess and higher reintervention rate, including emergency re-operations. Morbidity and mortality are not significantly different between LL and open surgery, but LL is associated with shorter operative time, fewer stomas, fewer postoperative cardiac and wound complications and a shorter hospital stay. The surgical technique for LL has not been standardized and disadvantages include the risk of missing a persistent perforation (30%), faecal peritonitis enclosed within the sigmoid loop (10%) and missing a sigmoid cancer (10%).

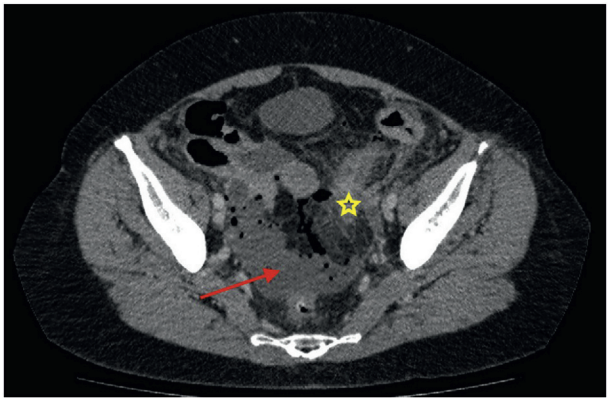

Figure 1 Axial CT image of the pelvis showing a diverticular phlegmon in association with the sigmoid colon (yellow star) and a large pelvic abscess containing bubbles of gas (red arrow). Percutaneous drainage should be considered in the first instance.

Resection by open or laparoscopic surgery for complicated AD is recommended if surgery is required; Hartmann's procedure is still the most common procedure of choice, although under exceptional circumstances primary anastomosis with diverting ileostomy may be undertaken by suitably trained surgeons. Hartmann's procedure (HP) or primary anastomosis with diverting ileostomy (PA) are the two surgical techniques most commonly used in patients undergoing emergency colectomy for perforated AD, with HP being the most performed technique. Surgeon-specific factors, including colorectal subspecialization, may influence the type of operation performed, with non-colorectal surgeons usually more likely to perform HP. Recent studies and meta-analysis have shown significantly lower overall mortality in patients with PA compared with HP. Surgical site infection rates, re-operation and stoma non-reversal rates were significantly decreased in PA, but at the expense of a longer mean operating time for PA compared with HP. When surgical resection is indicated, evidence to support or refute the safety and effectiveness of laparoscopic versus open approach is insufficient. The operating time is longer in laparoscopic than open surgical resection, although laparoscopic surgery improves postoperative pain control and reduces the duration of paralytic ileus. It is uncertain whether laparoscopic surgical resection improves postoperative mortality, morbidity and reoperations due to anastomotic leak. HP is recommended in haemodynamically unstable patients. The use of a damage control strategy involving resection without anastomosis, temporary abdominal closure, planned re-look and delayed stoma formation – or even delayed anastomosis – should be considered in the septic unwell patient at initial laparotomy.

Resection of acutely affected bowel should be undertaken, minimizing risks to adjacent structures and minimizing tension on a colostomy or anastomosis by selective mobilization of the splenic flexure. Limiting the resection to the segment that is acutely affected without compromising blood supply of the remnant bowel may be appropriate for HP. If primary anastomosis is undertaken, distal resection level at the top of the rectum and proximal resection level at a point where there are no diverticula are likely to reduce anastomotic events. Mobilization of the splenic flexure may be necessary selectively in order to ensure reduced tension on a colorectal anastomosis or an end colostomy but risks spread of contamination in Hinchey III and IV patients. Mesenteric division close to the bowel wall is likely to decrease the risk of ureteric injury, particularly in the presence of an inflammatory mass, at the expense of potentially troublesome bleeding. If a sigmoid cancer is suspected, oncological resection with higher ligation of the IMA/superior rectal artery and dissection in a mesocolic/mesorectal plane should be undertaken if possible. Division of healthy lower sigmoid or rectum below the affected segment is likely to be associated with a lower risk of stump closure dehiscence. Whilst rectal catheters are often placed to reduce the risk of stump dehiscence, there is little evidence demonstrating their specific benefit. Similarly, there is

Figure 2 (**a**) A diverticular abscess already penetrating through the left sciatic notch (arrow). (**b**) Percutaneous drainage by a transgluteal route. (**c**) A colocutaneous faecal fistula discharging contents into a fistula bag on the left buttock. The patient required a defunctioning loop colostomy and delayed Hartmann's resection.

no evidence to support the use of abdominal drains following surgery for perforated diverticulitis.[1]

Appendicular abscess and appendix mass

Acute appendicitis is the most common general surgical emergency worldwide. The lifetime risk of appendicitis is 7%–8%, with the highest incidence in the second decade. In the majority of cases, a diagnosis of appendicitis is reached through a combination of characteristic history of migratory right iliac fossa pain (RIF) associated with constitutional symptoms and abdominal examination eliciting tenderness and local peritonism. Risk prediction tools can also aid diagnosis. In young female patients, pelvic US may help to exclude alternative gynaecological diagnoses, and in older patients – or those with an atypical history – more detailed imaging with CT scanning may help to exclude important diagnoses such as ileocaecal Crohn's disease, caecal diverticulitis, caecal carcinoma or, indeed sigmoid diverticulitis affecting a sigmoid loop situated in the RIF.

In view of its single end (appendicular) artery, infarction follows inflammatory thrombosis of the appendicular artery followed by perforation and abscess formation. As most patients do not undergo imaging, many appendix abscesses are unexpectedly discovered at surgery. An 'appendix mass' forms in a patient with a longer history (over at least a week) in whom the inflammatory process of appendicitis is 'walled off' by omentum and adjacent bowel loops. The patient's general condition is likely to be improved and a variably tender mass will be palpable in the RIF. Following appropriate imaging to confirm the diagnosis, management is usually conservative with antibiotics in the expectation that the inflammatory process will resolve completely.

If an abscess is discovered at surgery (open or laparoscopic) it should be 'broken into' carefully so as to limit wider contamination of the abdomen and, if an open approach has been made, the wound should be protected. Appendicectomy should be undertaken, which may be more difficult in the presence of an abscess and associated induration. Perforation at the base of the appendix may necessitate caecectomy or even ileocaecal resection, especially if the diagnosis is uncertain. If an unexpected appendiceal tumour is identified, an appendicectomy is sufficient in tumours less than 10 mm with clear resection margins. If an appendiceal tumour larger than 10 mm or caecal tumour is suspected, right hemicolectomy should be performed[2] (Figure 3).

Drainage of an appendix abscess may allow more rapid resolution of the illness and persistence with conservative management. The abscess must be safely accessible under CT guidance (Figure 4). Appendiceal fistula may result, which should raise the suspicion of Crohn's disease (Figure 5).

The role of interval appendicectomy following resolution of an appendix mass remains controversial and is not mandatory unless a fistula supervenes. Endoscopic and cross-sectional imaging should be undertaken to exclude malignancy or inflammatory bowel disease. Ultimate appendicectomy has the

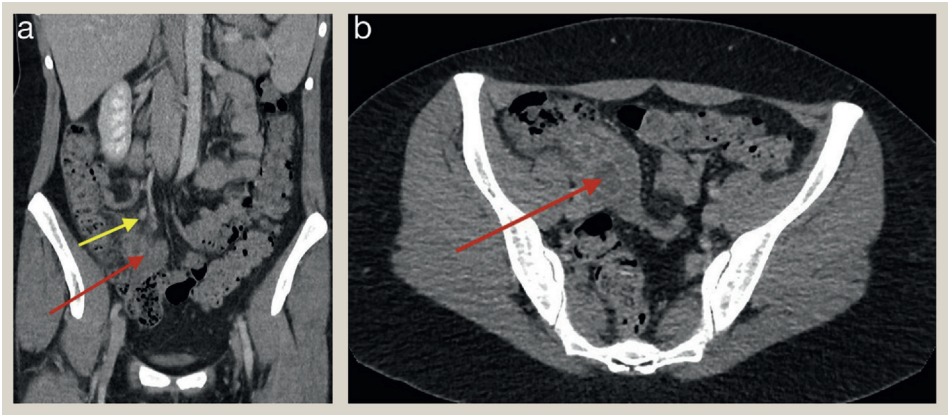

Figure 3 (**a**) Coronal CT showing inflammatory appendicular mass (red arrow) and enlarged mesenteric lymph node (yellow arrow). (**b**) Axial section of same patient showing fluid and distended appendix. Laparoscopic right hemicolectomy was carried out on suspicion of appendiceal tumour; adenocarcinoma of the appendix was confirmed on histological examination.

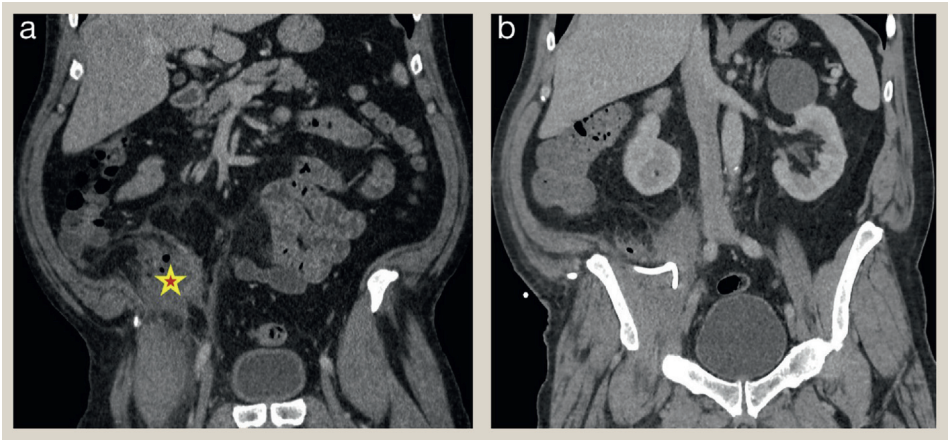

Figure 4 Coronal CT images of appendiceal abscess (star) lying posteriorly (**a**) pre-percutaneous and (**b**) post-percutaneous drainage with complete resolution of symptoms.

advantage of not overlooking occult appendiceal pathology such as neuroendocrine tumour or cancer. If appendicectomy is undertaken, an interval of at least 3–6 months is sensible.

Appendicectomy can be performed by either a laparoscopic or open approach. Intra-abdominal abscess complicates 2%–3% of patients having appendicectomy for acute appendicitis and, although the laparoscopic approach is associated with fewer surgical site infections, reduced length of stay and earlier return to oral intake, there is no difference in the incidence of postoperative abscess compared with an open approach. There is no demonstrated advantage for peritoneal lavage compared to irrigation alone for intra-abdominal collections in complicated appendicitis.[3,4] There is no role for the routine placement of drains following appendicectomy for complicated appendicitis. If postoperative abscess occurs, the management is prolonged antibiotics and percutaneous drainage if accessible, but this can fail in up to 25% of patients. Early re-laparoscopy or re-operation and washout may be required in patients with persistent sepsis.

Crohn's disease

Abscesses may be seen in association with perforating Crohn's disease (CD) at any location in the gastrointestinal tract, particularly the terminal ileum. In the absence of generalized peritonitis, management should be conservative in the first instance following appropriate imaging, usually with CT, although MR enterography or ultrasound may also be advocated. Percutaneous drainage of abscesses, antibiotics and combined involvement of surgeons and gastroenterologists should be considered as first line treatment in stable patients. Small abscesses <3 cm should be treated with intravenous antibiotics with an awareness of risk of recurrence, particularly if associated with enteric fistula. Once the septic episode has resolved, medical salvage and disease stability may be achieved with immunosuppressant medication but a lower threshold for early resectional surgery should be adopted if such a septic event has occurred. Enteral nutrition may be continued in the setting of penetrating CD with associated abscess formation and decreases the risk of surgical intervention. Immediate emergency surgery for ileocaecal CD in the presence of an abscess is more likely to be associated with an anastomotic event if continuity is immediately restored and so an end ileostomy is usually advisable, especially if the patient is on steroids, malnourished or hypoalbuminaemic.

Tubo-ovarian abscess

Gynaecologists usually deal with abscesses arising from gynaecological organs, but tubo-ovarian abscesses may be discovered at laparoscopic or open surgical exploration by general surgeons. The distinction between primary tubo-ovarian abscess and appendicular abscess secondarily affecting the Fallopian tube, fimbriae and ovary may be difficult (Figure 6). If the appendix is involved with the inflammatory process it will usually need to be removed. Tubo-ovarian abscess is a serious sequel of pelvic inflammatory disease, usually occurring in women aged 20–40

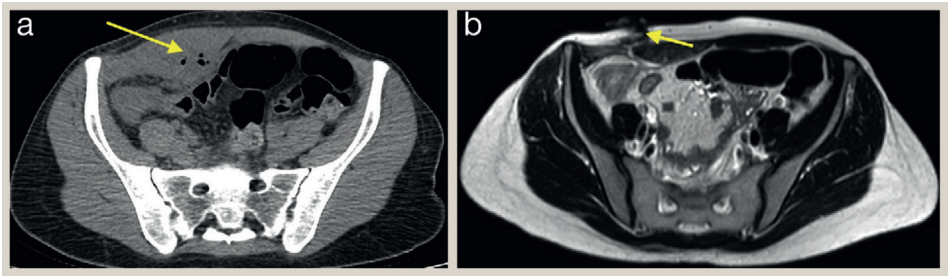

Figure 5 (**a**) Axial CT image showing gas-containing appendiceal abscess (arrow) just beneath the anterior abdominal wall, drained percutaneously. (**b**) T2-weighted MRI demonstrating appendiceal fistula (arrow) following percutaneous drainage. Laparoscopic ileocaecal resection was undertaken 6 months later, histopathology being equivocal for Crohn's disease.

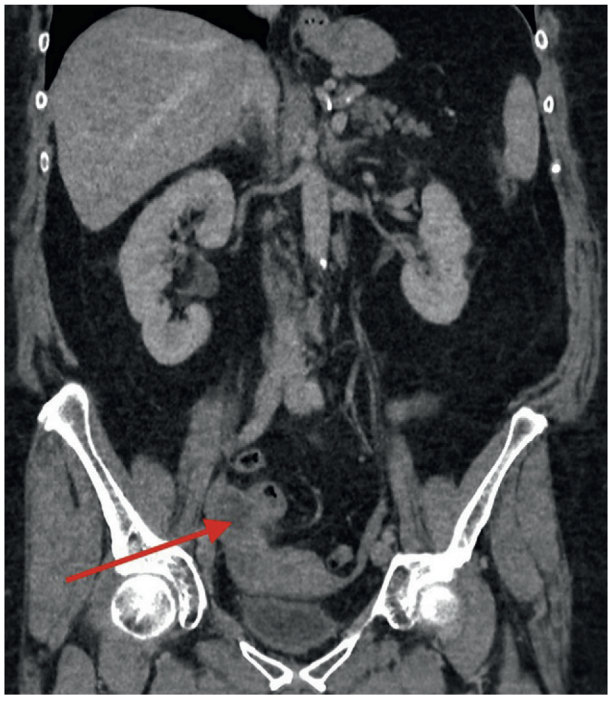

Figure 6 Coronal CT scan showing an abscess (arrowed) in the right adnexal region in association with the right ovary, Fallopian tube and appendix, the exact origin being uncertain.

years and up to 59% of these women are nulliparous. Pregnancy rates after tubo-ovarian abscess may be as low as 15% or less. Treatment options depend on whether intra-abdominal rupture has occurred and includes medical management with antibiotics, immediate laparoscopic drainage within 24 hours and fertility preserving, conservative surgery.

Abscesses in association with colorectal cancer

Perforation is an uncommon presentation of colorectal cancer, representing 1.6%–4.1% of all colorectal cancers and 18.6%–28.4% of emergency cancer presentations, with early mortality between 20% and 62%. Perforation occurs at the site of the cancer in 65%–92% and proximal to the cancer in 3%–35%. While perforation proximal to the tumour in an obstructed colon may lead to diffuse peritoneal contamination, perforation at the tumour site itself tends to result in local contamination and a lower risk of severe peritonitis but a higher risk of local tumour recurrence and peritoneal carcinomatosis with no influence on distal metastases. However, the influence of perforation on long-term oncological outcomes and survival remains unclear although does appear to be an independent negative prognostic factor.[1,5]

Generalized perforation and peritonitis mandates surgical intervention, unless the patient is considered unsalvageable physiologically or in the face of overwhelming metastatic disease, in which case a palliative approach may be more appropriate. A localized contained abscess allows time to consider the most appropriate surgical strategy in order to optimally deal with sepsis while adhering to the principles of cancer management. While percutaneous drainage of a radiologically accessible abscess associated with a colonic cancer may be feasible, malignant cells theoretically may seed along the drainage track. Consideration as to the direction of percutaneous drainage may, therefore, be important so as to allow track excision at the time of surgery. Surgical resection of colon cancer in the presence of abscess from local perforation may be considered palliative in view of the greater risk of local recurrence, but in the absence of distant or peritoneal metastases, radical resection of the primary tumour should be undertaken if possible. The abscess cavity should be irrigated with water, curetted (samples being sent for histological analysis) and marked with radiologically opaque clips for potential radiotherapy. Primary anastomosis may be undertaken under favourable conditions, but the anastomosis should be excluded from the abscess cavity by burying it within bowel loops or omentum or placing omentum in the cavity. Alternatively, an end stoma may be raised, eliminating the risk of anastomotic leak and its consequences, including an inability to proceed with chemotherapy.

Local perforation of rectal cancer with pelvic abscess is relatively unusual but is a challenging situation and oncological outcomes are usually poor. Emergency surgery is rarely indicated

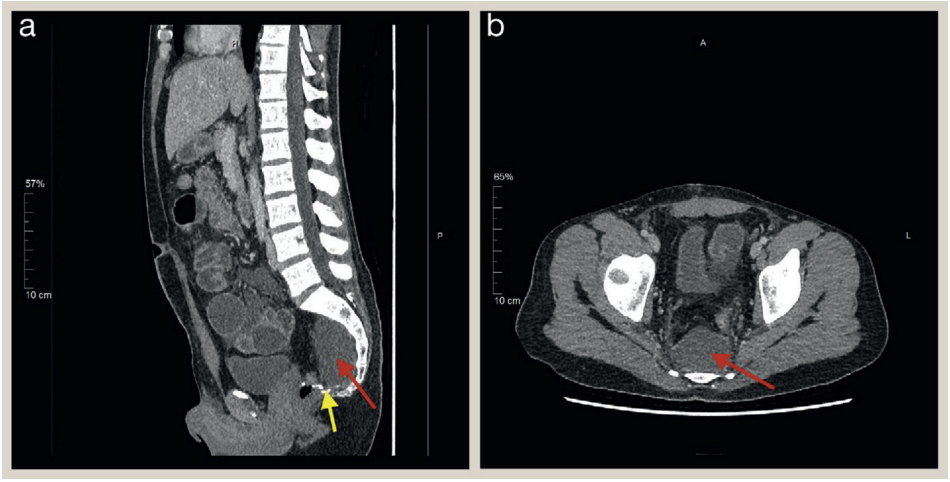

Figure 7 (**a**) Sagittal and (**b**) axial CT images of presacral abscess (red arrows) 2 weeks following robotic low anterior resection. At examination under anaesthetic the anastomotic staple line (yellow arrow) was intact and 40 ml of pus was aspirated from within the lumen of the neorectum with full resolution.

and initial percutaneous, intraluminal or operative drainage and raising an upstream colostomy or ileostomy allows time for confirmation of the diagnosis, more accurate staging and treatment planning.

Postoperative pelvic abscess

Pelvic abscess may occur in the postoperative period under the following circumstances:

- residual/persistent sepsis following any surgery for perforated viscus
- infected haematoma following pelvic surgery
- overlooked small bowel enterotomy
- anastomotic leak, including appendix stump blowout.

Infected haematomas or residual abscesses may be amenable to percutaneous drainage. Re-operative surgery is rarely indicated but may be more feasible if the initial surgery was undertaken laparoscopically, in which case laparoscopic washout may hasten the patient's recovery. Radiologically guided drainage of postoperative pelvic abscesses, whether or not in association with anastomosis, may be undertaken by transabdominal or transgluteal routes, as for any pelvic abscess. Transanal aspiration of pelvic abscess in the absence of obvious dehiscence may occasionally be possible (Figure 7).

Conservative management of enterotomy-associated abscess or appendix stump dehiscence with percutaneous drainage is more likely to result in an enterocutaneous fistula. Earlier surgery (within 10 days) on suspicion of these events may allow for surgical salvage, either with primary repair or exteriorization.

Pelvic abscess from anastomotic leak mandates senior surgical input and decision making. Most commonly, this event follows a failed pelvic anastomosis such as a colorectal or coloanal anastomosis after rectal cancer surgery. A high index of clinical suspicion should be adopted, especially if a patient is failing to progress in the first week after surgery or inflammatory markers (especially CRP) remain elevated. Careful digital examination of a low anastomosis by an experienced colorectal surgeon allows confirmation and extent of dehiscence. This should be confirmed by multiplanar CT scanning, ideally with the addition of rectal contrast (Figure 8).

Management of pelvic anastomotic leak is challenging and requires considerable vigilance and investment of surgical time and energy if salvage of the anastomosis is to be achieved. The approach chosen will be determined by the patient's physiology and degree of sepsis, but the broad choices usually include some, or all, of the following:

- laparoscopic or open washout, drainage and raising an upstream stoma (if not already defunctioned)
- per-anal trans-anastomotic washout and drainage using either passive tube drainage or negative pressure therapy sponge dressings
- disconnection of the anastomosis and raising of an end colostomy with closure of the rectal stump if possible.

Colonic anastomotic leaks and abscess

The same broad principles apply to extra-pelvic anastomotic leaks, the important choice lying between a conservative or re-operative approach and whether, if surgery is required, the anastomosis needs to be disconnected with raising of one or both ends or, exceptionally, repaired. Salvage of a dehisced anastomosis at emergency re-do surgery is rarely successful and disconnection or exteriorization is usually safer.

Percutaneous drainage of an accessible peri-anastomotic collection in an otherwise well patient is worthwhile, although an enterocutaneous fistula may result, requiring much-delayed future surgery at least 6 months later. Large abscesses may also be tackled by percutaneous or surgical drainage alone, especially if re-laparotomy is considered unwise (Figure 9).

Figure 8 Sagittal CT of a patient 7 days following laparoscopic anterior resection showing pre-sacral gas-filled abscess (arrow) from anastomotic leak (the staples can be clearly seen). The patient already had a loop ileostomy and the leak was treated with a negative pressure sponge dressing inserted endoscopically into the cavity from within the lumen of the neorectum.

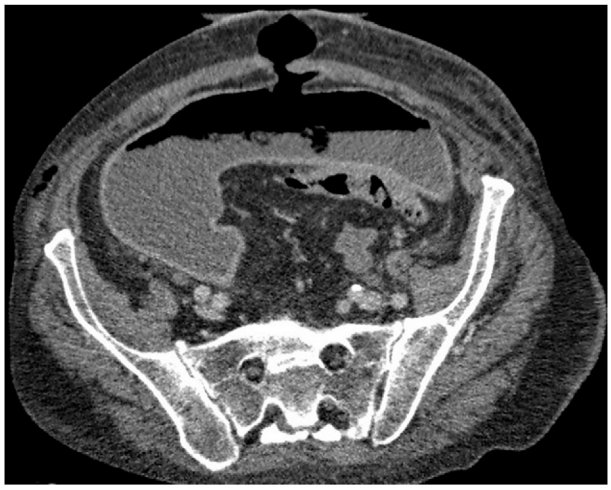

Figure 9 Axial CT 2 weeks following right hemicolectomy. A large gas-containing abscess cavity is seen implying a major anastomotic leak. This was managed by 'conservative' surgical drainage and TPN with the formation of a controlled enterocutaneous fistula.

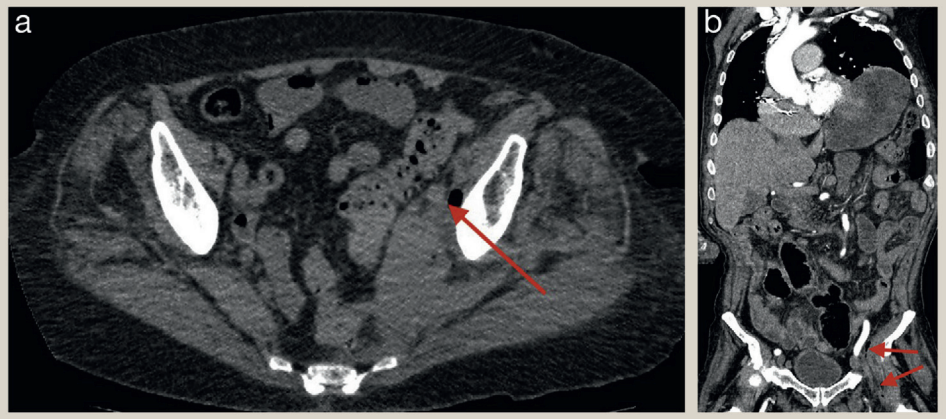

Figure 10 (**a**) Axial CT showing left psoas abscess with gas bubble (arrowed) from perforation of adjacent diverticula-affected sigmoid. (**b**) Coronal section clearly shows gas tracking along the left psoas tendon (arrowed).

Psoas abscess

Historically, psoas (more accurately iliopsoas as the iliacus muscle is frequently involved) abscesses were commonly associated with spinal tuberculosis (Pott's disease) but are now more commonly seen in cases of perforating sigmoid diverticulitis affecting the left iliopsoas (Figure 10) and, on the right, penetrating ileocaecal Crohn's disease or appendicitis. The action of the psoas muscle is to flex and internally rotate the hip owing to its tendinous insertion into the lesser trochanter and so patients with irritation of the psoas muscle by an abscess may hold the hip in this fixed position. This may also elicit a positive aggravating 'psoas stretch test'. With a neglected psoas abscess, pus may track along the psoas tendon to appear as a swelling below the inguinal ligament.

Treatment where possible should be primary radiological drainage followed by delayed surgery, depending upon the intestinal pathology. At surgery an attempt should also be made to drain any residual sepsis within the psoas muscle.

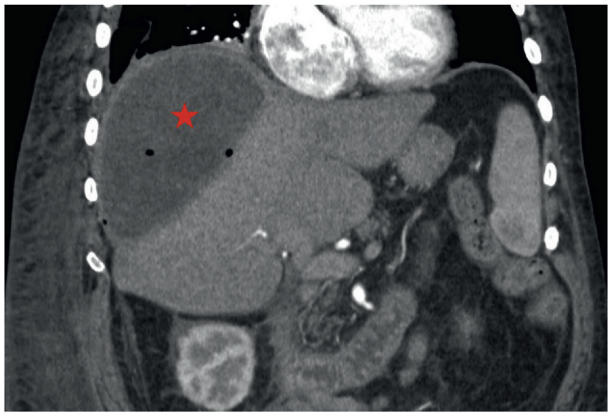

Figure 11 Large right subphrenic abscess (star) secondary to a perforated gallbladder.

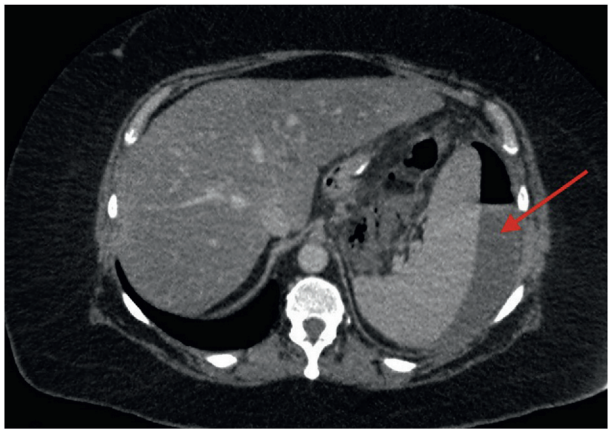

Figure 12 Large left subphrenic and perisplenic abscess (arrowed) 1 week following a gastric sleeve operation for obesity.

Subphrenic and sub-hepatic abscess

Pus may accumulate below the diaphragm following any intraperitoneal septic insult as a primary event or following surgery. While various anatomical and potential spaces are defined, in practical terms pyogenic collections are more often bound by inflammatory adhesions rather than defined hepatic ligaments. At laparotomy for purulent, biliary or faeculent peritonitis, it is important that thorough lavage of the subphrenic spaces over the liver, stomach and spleen is undertaken in order to reduce the chance of this complication. Purulent fluid following perforated duodenal ulcer or perforated gallbladder may favour the right subphrenic space and may be very large (Figure 11). Complications of gastric, pancreatic, splenic or colonic surgery may result in left subphrenic collections (Figure 12).

In addition to a swinging 'spiking' fever – typical of any intra-abdominal abscess – patients with a subphrenic abscess may complain of back pain, chest pain or shoulder tip pain from diaphragmatic irritation. There may be dyspnoea owing to reactionary lower lobe collapse or pleural effusion on the other side of the diaphragm, signs which may be evident radiologically on a plain chest radiograph. Often symptoms and signs are obscure, which led historically to the surgical aphorism: 'pus somewhere, pus nowhere, pus under the diaphragm'.

Percutaneous drainage is usually possible under ultrasound or CT-guided control. Fluid from subphrenic collections following splenectomy or pancreatic surgery should be tested for amylase content in view of the potential for pancreatic fistula.

Endoscopic ultrasound-guided intra-luminal drainage of peri-pancreatic and perihepatic collections may be possible, eliminating the need for an external drain, minimizing the risk of fistula formation and preventing fluid and electrolyte losses. Rarely is open surgical drainage of a subphrenic abscess required, but this can be achieved through a posterior extra-peritoneal approach via the bed of the 12th rib, if necessary, rather than via laparotomy.

Sub-hepatic abscesses are most likely to be seen as a result of a perforated gallbladder or perforated duodenal ulcer (DU) but may also be associated with perforating colonic disease (usually Crohn's or cancer) affecting the hepatic flexure or proximal transverse colon. Treatment will depend upon pathology, but percutaneous drainage in the first instance may be worthwhile, accepting that an enteric fistula may result following DU or colonic perforation. A perforated gallbladder may need removal or, in a less well patient, cholecystostomy.

Occasionally, perforated duodenal ulcer may present as an abscess in the right iliac fossa from enteric fluid tracking down the right paracolic gutter. Signs of tenderness and local peritonism may lead the unwary to suspect acute appendicitis and, while imaging may remain equivocal, laparoscopic exploration ought to clinch the diagnosis allowing for appropriate treatment. ◆

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Practice points

- Diverticular abscesses should be drained percutaneously under radiological guidance if access can be safely obtained, usually via transabdominal, transgluteal or transvaginal routes
- Successful drainage of a diverticular abscess may provide sufficient long-term definitive treatment but the colon must be subsequently evaluated to exclude colorectal cancer
- An appendix abscess or mass may be successfully managed by percutaneous drainage and antibiotics following which delayed interval appendicectomy is usually recommended, although in older patients colonoscopic evaluation of the caecum should be undertaken
- Successful treatment of intestinal Crohn's disease abscesses will usually need to be followed by resectional surgery
- Contained colorectal cancer-associated abscesses occur with tumour perforation and a higher risk of local recurrence but, in the absence of metastatic disease, should be managed with curative intent
- Retroperitoneal and psoas abscesses occurring with penetrating intestinal disease may present insidiously and resectional surgery is usually required
- Primary anastomosis following surgery in the presence of sepsis should only be undertaken if physiological and operative circumstances permit; stomas should be used liberally
- Salvage of a leaking anastomosis occurring after anterior resec-tion requires extreme vigilance, early detection and endoluminal therapy