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Appendicitis and diverticulitis of the colon: Misleading forms

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KEYWORDS

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Abstract Appendicitis and diverticulitis of the colon are the two main causes of febrile acute abdomen in adults. Diagnosis from imaging (ultrasound and CT) is usually easy. However, an imaging procedure which is not suitable for the clinical situation and an examination performed with the wrong protocol are sources of error and must be avoided. Anatomical variants, inflammatory cancers, complicated forms (perforation, secondary occlusion of the small intestine, peripheral abscesses, fistulae, pylephlebitis, liver abscesses) and associated signs related to a peritoneal inflammatory reaction (reflex ileus, reactive ileitis or salpingitis) can also lead to a wrong diagnosis.

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Diverticulitis of the colon and appendicitis are the most common reasons for consulting for acute abdominal pain with a raised temperature. Diagnosis of them is based largely on imaging data (ultrasound and CT); the classic radiological signs of appendicitis and diverticulitis are simple and their diagnosis from imaging is often easy. However, atypical presentations can lead to a wrong diagnosis due to:

- traps related to the use of an unsuitable technique;
- traps related to the anatomy (anatomical variations);
- traps related to complications;
- the existence of many alternative diagnoses that can mimic diverticulitis of the colon or appendicitis.

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Urinary and gynaecological conditions can also mimic appendicitis but will not be developed in this paper. The focus here is on:

- providing a concise reminder of the techniques used (ultrasound and CT), and the results for typical forms, emphasising the diagnostic traps associated with poor or inappropriate techniques;
- illustrating the traps related to complicated forms or anatomical variants;
- being aware of the main differential diagnoses and suggesting them.

Exploration techniques

Ultrasonography

Technique

The ultrasound examination is carried out with a low frequency probe (3.5 MHz) to explore the entire abdominal cavity, then a surface probe (6–12 MHz) to search for the appendix or abnormality of the colon wall. Graduated compression, described by Puylaert, is an essential step in the diagnosis. It not only helps precisely locate the pain, but also reveals the non-compressibility of any inflammatory tissues (lumen of the appendix or colon, inflammatory fat), which is a very good diagnostic sign. Omitting this technical approach is a known source of diagnostic error [1,2]. Transvaginal ultrasound, in women of childbearing age, is essential not only to eliminate a gynaecological condition but also to make a positive diagnosis of pelvic appendicitis or sigmoid diverticulitis.

Results

Appendicitis

An ultrasound examination should be preferred as the first-line investigation when confronted with acute febrile pain in the right iliac fossa suspected of being appendicitis, particularly when the patient is young [3]. The normal appendix appears as a structure with a blind end arising from the bottom of the caecum, with no peristalsis and having the appearance of a digestive structure [4]. In ultrasound, an abnormal appendix is non-compressible, non-peristaltic and has a diameter of more than 6 mm, associated with infiltration of the periappendiceal fat that appears hyperechoic [3–5].

There are numerous diagnostic traps with ultrasound:

- false negatives: not seeing a normal appendix should not be considered reassuring; the appendicitis may be retrocaecal, mesocolic, pelvic or even perforated; an appendix which is not entirely visible can mean not recognising distal appendicitis [6];
- false positives: they are less common and concern tubular structures (fallopian tubes, small intestine, dilated ureters) mistaken for appendicitis [7]. The particular case of right diverticulitis with a coprolith at the base of the inflamed diverticulum is a classic source of error. Finding a normal appendix in its usual position is of primary importance.

Diverticulitis

Typically, diverticulitis produces thickening of the wall of the colon, retaining the layers, which is surrounded by hyperechoic inflammatory fat. The whole structure is painful and incompressible as the probe passes over. An inflamed diverticulum is sometimes visible: its wall is thickened and surrounded by hyperechoic inflammatory fat; its lumen sometimes contains a coprolith producing a posterior shadow cone [8,9].

CT scan

CT has assumed a prominent position in exploration of febrile acute abdomen by enabling comprehensive examination of the digestive tract, its wall and its fatty environment [10–13].

Technique

Acquisition without injection of the entire abdomen and pelvis (120 kV, or 100 kV for thin subjects, 30 to 50 mAs) is indicated to adapt the injection protocol, eliminate any contraindication to an enema (voluminous pneumoperitoneum, occlusion) and better visualise any foreign body (a coprolith) [14]. Diverticulitis and appendicitis can be positively diagnosed without injection of a contrast agent [15–17]. However, in thin individuals with little intraperitoneal fat, injection of a contrast agent helps localise abnormalities better by showing the inflamed colon or appendiceal walls which will be intensely enhanced (Fig. 1). Finally, certain serious complications of appendicitis and diverticulitis (perforation, abscess, pylephlebitis), the presence of which may alter therapeutic management, are much more visible in contrast-enhanced examinations [10].

If there are no contraindications, images are acquired covering the whole of the abdomen and pelvis, after injection of 1.5 ml/kg of iodinated contrast agent containing 350 mg/cl, with an injection rate of 2.5 ml/s, in the portal phase (70 seconds).

The focused CT technique, consisting of a selective study of the submesocolic abdomen and pelvis, has been supported essentially by Rao, who argues that it is less irradiating [18–20]. However, two studies have clearly shown that not exploring the supramesocolic abdomen in a patient presenting pain in the right iliac fossa significantly reduced the sensitivity of CT for diagnosis of all the possible differential diagnoses of surgical acute abdomen [21].

The need to develop low dose scans, especially in young patients, appeared with multi-detector row CT [17,22]. The indications must be discussed and each acquisition must be optimised. In response to the growing preoccupation with radiation protection, manufacturers have recently introduced a protocol for CT reconstruction based on a mathematical algorithm applied to the raw data, with the aim of improving the signal/noise ratio, the ultimate goal being to obtain good quality slices with a minimum dose.

Opacification via the rectum with water or diluted water-soluble agents (2–3%) is not essential for diagnosis. However, it has a number of advantages:

- it helps in identifying the bottom of the caecum (especially in an ectopic situation), which is sometimes very difficult in thin subjects with no intraperitoneal fat;

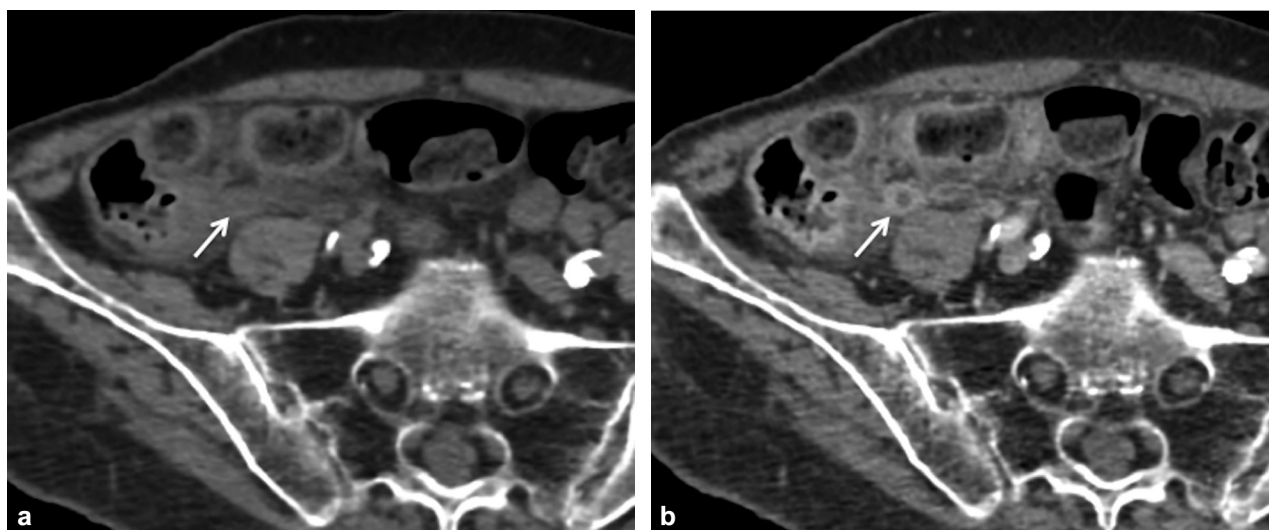


Figure 1. Acute appendicitis: the contribution of injection of an intravenous contrast agent: a: axial slice without injection: considerable infiltration of the pericaecal region in which the appendix cannot be clearly identified (arrow); b: axial slice after injection: the appendix is clearly visible due to the considerable annular enhancement of its inflamed wall, with a “target” image (arrow).

- it facilitates examination when the wall of the colon is thickened (appendicitis complicated by caecitis, diverticulitis complicated by an intraparietal abscess) [19];
- it eases diagnosis when injection of a contrast agent is contraindicated [20].

At present, there is no agreement as to whether the ideal contrast material in both situations is water [23,24] or a diluted water-soluble iodinated contrast agent. Where diverticulitis is suspected, diluted water-soluble contrast opacification should be preferred to show up a fistula tract or communication between the lumen of the colon and an abscess.

Oral opacification with water or a diluted water-soluble iodinated contrast agent should not be undertaken in the event of febrile acute abdomen.

Multiplanar reconstructions are a great help in examining an acute abdomen. They are particularly useful where there are anatomical variants [25–27].

Results

Appendicitis

An inflamed appendix has a diameter greater than 6 mm in CT images and circumferential thickening of its superior wall equal to or greater than 3 mm. Periappendiceal inflammatory signs are easy to identify with CT and are often the key to diagnosis [28].

CT diagnostic traps due to an inadequate technique (no injection of iodinated contrast agent, no opacification of the colon) are not seeing the appendix due to the absence of visceral fat in thin patients, or because of a perforated appendicitis, and an unrecognised ectopic caecum.

Diverticulitis

In CT, the signs of uncomplicated diverticulitis associate signs involving the colon wall (thickening, diverticula) with pericolic fat abnormalities, consistently found as densification. Isolated thickening of the wall of the colon with diverticula is generally due to muscular thickening

(myochosis) which contributes to diverticulosis. In so-called “severe” forms, the previous signs are associated with the presence of gas in an extra-digestive position and/or the presence of one or more mesosigmoid abscesses or a remote abscess in the peritoneal cavity.

The main diagnostic trap as regards CT concerns the time it is performed [29,30]. An examination which is performed too late may no longer pick out the CT signs of diverticulitis (Fig. 2). The examination must be performed within 24 hours of a patient’s admission to hospital, and within 72 hours of diagnosis and the initiation of antibiotic treatment for out-patients, i.e. generally within 48 hours.

Diverticulitis: misleading forms

Despite a usually easy diagnosis with CT, anatomical variations and complicated forms can lead to wrong diagnosis [31].

Locations and atypical forms

While the majority (90%) of incidents of diverticulitis occur in the sigmoid colon, any segment of the colon can be affected, including the rectum.

Diverticulitis with retroperitoneal repercussions

Forms with retroperitoneal expression are naturally the preserve of diverticulitis of the fixed parts of the colon, located in the anterior pararenal space of the right and left colon. Involvement of a posterior diverticulum can result in an effusion or thickening of the retroperitoneal fascia, a retroperitoneumoperitoneum, or urethritis [32] (Fig. 3).

Diverticulitis of the right colon and caecum is rare (1.5%) in Western countries but poses a particular problem. Its clinical diagnosis is almost never made, but there are many differential diagnoses of inflammatory or tumour diseases when there is pain in the right iliac fossa. The CT signs



Figure 2. Sigmoid diverticulitis: complete healing a considerable time after medical treatment: a, b: axial slices: uncomplicated sigmoid diverticulitis: thickening of the wall of the colon (thick arrow) with two diverticula (thin arrow), infiltration of the fat and perisigmoid liquid effusion (star); c: axial slice: complete disappearance of the thickening of the colon wall and local inflammatory signs after 2 weeks of antibiotic treatment.

of right colonic diverticulitis were first described by Baltazar et al. and are no different from those described for sigmoid diverticulitis [33]. Jang et al. and Rao et al. have suggested adding the sign of an inflamed diverticulum [18,34,35], which is a diverticulum in the centre of pericolic fat, the walls of which are thickened and the virtual lumen sometimes the site of a clearly visible coprolith on non contrast-enhanced acquisitions (Fig. 4). Its presence eliminates appendicitis and right colon cancer with excellent specificity [35].

Diverticulitis of the transverse colon

Because of its rarity, the clinical presentation of diverticulitis of the transverse colon first of all leads to considering the common causes of epigastric pain (cholecystitis, gastroduodenal perforation, pancreatitis) [36]. It is often difficult to distinguish between cholecystitis and transverse diverticulitis where the infiltration of the pericolic fat extends to the bed of the gallbladder (Fig. 5). Ultrasound examination of the wall of the gallbladder can often point the diagnosis in the right direction.

Diverticulitis of a giant diverticulum

The size of diverticula varies (2–3 mm to 2 cm). A giant diverticulum is defined as being more than 4 cm in size and is rare: only 150 cases have been reported in the literature [37]. It should not be mistaken for a pericolic abscess and, where there is the slightest doubt, percutaneous drainage should be contraindicated. It is often diagnosed retrospectively due to persistence after antibiotic treatment of a large gas-filled image communicating with the lumen of the colon (Fig. 6).

Complicated diverticulitis

Diverticulitis creates locoregional inflammation which, step by step, affects pericolic fat, the mesentery, the

retroperitoneum and the pelvic subperitoneal space, causing initial failure to diagnose diverticulitis.

Complications, which can be striking and in the forefront, may mask the aetiological diagnosis.

Perforation and abscess formation

This is seen as the presence of extra-digestive gas bubbles, an air-liquid collection in the adjacent fat, colon wall or at a distance from it [38].

The sigmoid colon has two sides, a mesosigmoid side and an anti-mesosigmoid side (or mesenteric surface). Most diverticular perforation of the sigmoid occurs in the mesosigmoid, which explains the absence of a voluminous pneumoperitoneum. Conversely, perforation on the free side (or mesenteric surface) of the sigmoid is more serious, resulting in voluminous pneumoperitoneum (often supra- and submesocolic), with an increased risk of faecal peritonitis (Fig. 7).

Occlusion of the small intestine

Occlusion of the small intestine secondary to diverticulitis is rare and often of mixed mechanical and functional origin [39]. It is usually associated with perforation on the anti-mesosigmoid side; the loops of the small intestine become impacted around the site of the intraperitoneal infection so that there may be failure to recognise diverticulitis. It is important to think of this when faced with a picture of febrile occlusion and to diagnose it, because treatment is often surgical.

Occlusion of the colon

This constitutes 10% of all organic colon occlusions [40].

It is explained by two associated physiopathological mechanisms:

- thickening of the muscle layer within the colon wall by fibrosis (myochosis), related to recurrent episodes of diverticulitis and responsible for a chronic sub-occlusive state;

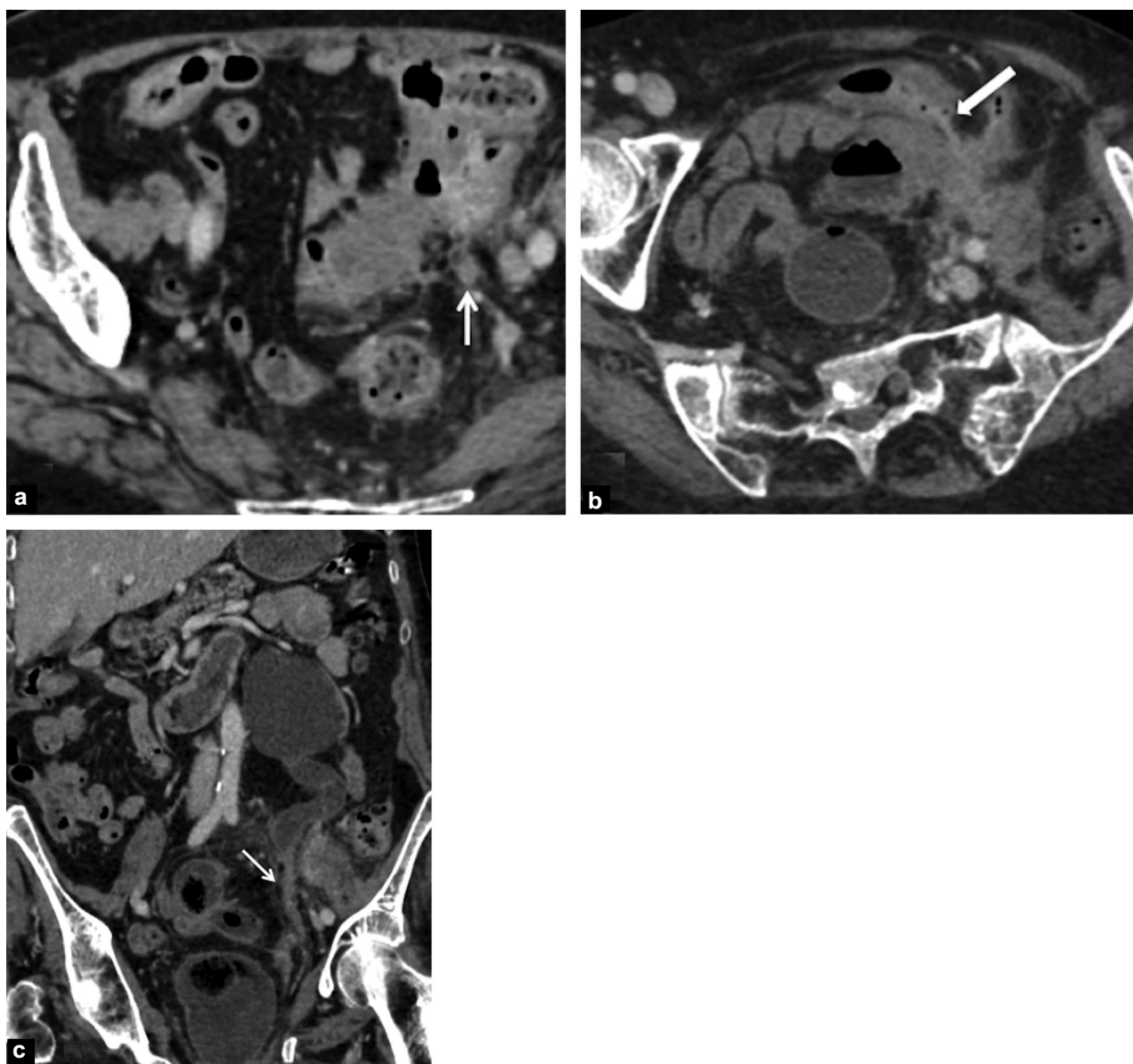


Figure 3. Sigmoid diverticulitis complicated by urinary involvement (bladder and ureter): a: axial slice: colon with a thickened wall and pericolic infiltration in contact with the left pelvic ureter (arrow); b: axial slice: sigmoid-vesicular fistula (thick arrow) with intravesicular air; c: coronal slice: obstructive hydronephrosis due to long inflamed ureteral stenosis (arrow).

- thickening of the colon wall due to submucosal oedema, related to acute inflammatory phenomena, and responsible for worsening the sub-occlusive state (Fig. 8).

In this context, it is often impossible to distinguish the condition from inflammatory colon cancer [41].

Fistulation and impact on adjacent organs

Some fistulae are relatively simple to diagnose with CT, as is the case for colovesical fistulae where the presence of gas in the anterior part of the bladder indicates the diagnosis. The diagnosis of parietal (intra-mural) fistulae and entero-enteric fistulae is much more difficult. Only a third of surgically proven fistulae are diagnosed by CT [13,41].

Pylephlebitis

Pylephlebitis is septic thrombosis of the portal vein or a vein draining the diseased segment of the colon. In an image without contrast injection, it should be suspected where the lumen is hyperdense, sometimes associated with an air bubble [42]. However, diagnosis with certainty relies on finding an endoluminal defect on a contrast-enhanced image (portal phase, 70 to 80s) (Fig. 9). It is important to diagnose pylephlebitis, as effective anticoagulation must be combined with the antibiotic treatment.

Liver abscess

A rare but classic complication, liver abscess is linked to haematogenous spread of the microorganism (Fig. 9c). A

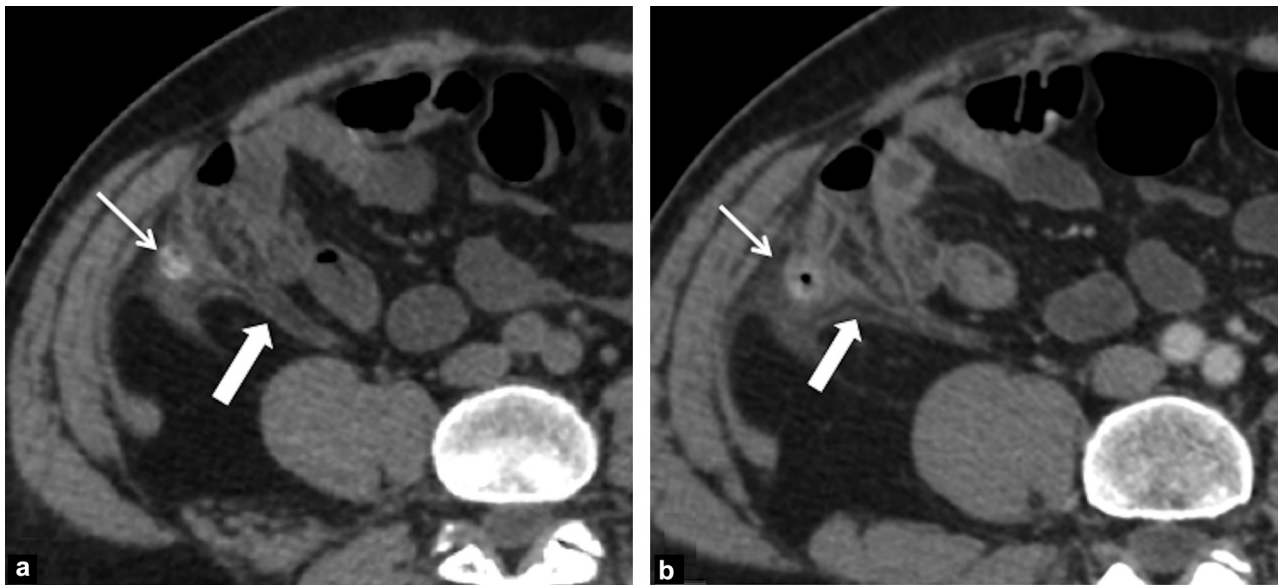


Figure 4. Right diverticulitis with an inflamed diverticulum: a: without injection and; b: with injection: diverticulum containing a coprolith with thickened and enhanced walls (thin arrow) in the centre of infiltration of the pericolic fat; thickened retroperitoneal fascia (thick arrow).

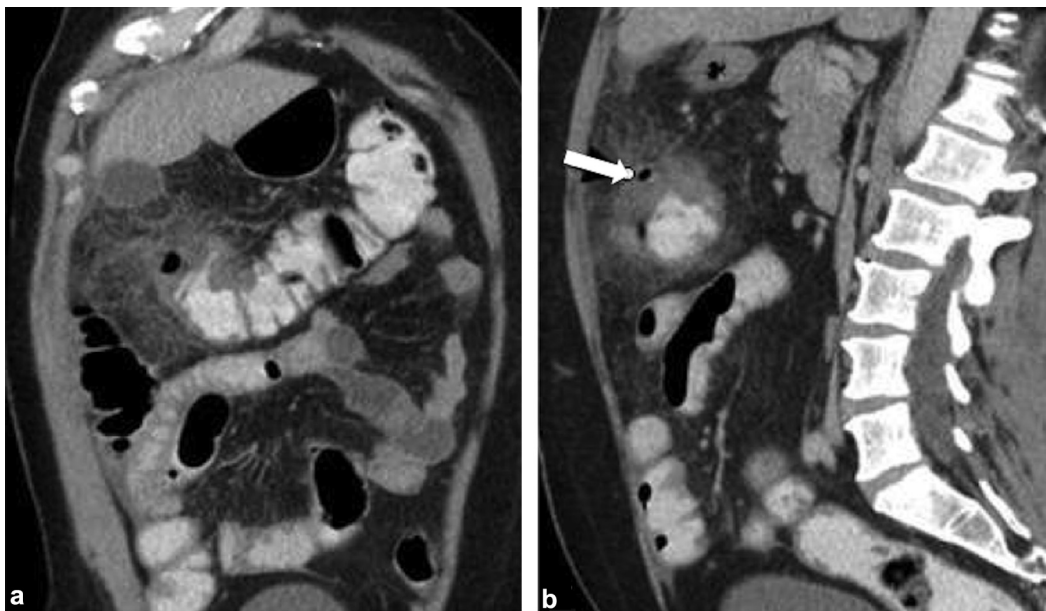


Figure 5. Diverticulitis of the right colic flexure mimicking cholecystitis: a, b: coronal and sagittal slices: colonic diverticulitis of the right colic flexure; infiltration of the peripheral fat extends to the bed of the gallbladder (arrow).

digestive cause should be sought for any liver abscess. Colon diverticulitis is nowadays the principal cause of liver abscesses of digestive origin.

Differential diagnoses

It is essential to know the differential diagnoses, especially those which can be sources of diagnostic error, because of their therapeutic implications.

Differential diagnoses for focal infiltration of the pericolic fat

Primary epiploic appendagitis results from twisting and/or ischaemia of a fatty fringe attached to the colon; it is more frequent on the left and clinically can pose the problem of differential diagnosis with sigmoid diverticulitis. CT is effective for confirming the diagnosis given the characteristic signs: a rounded oblong mass of fat density attached to the colon, surrounded by a dense ring and associated with

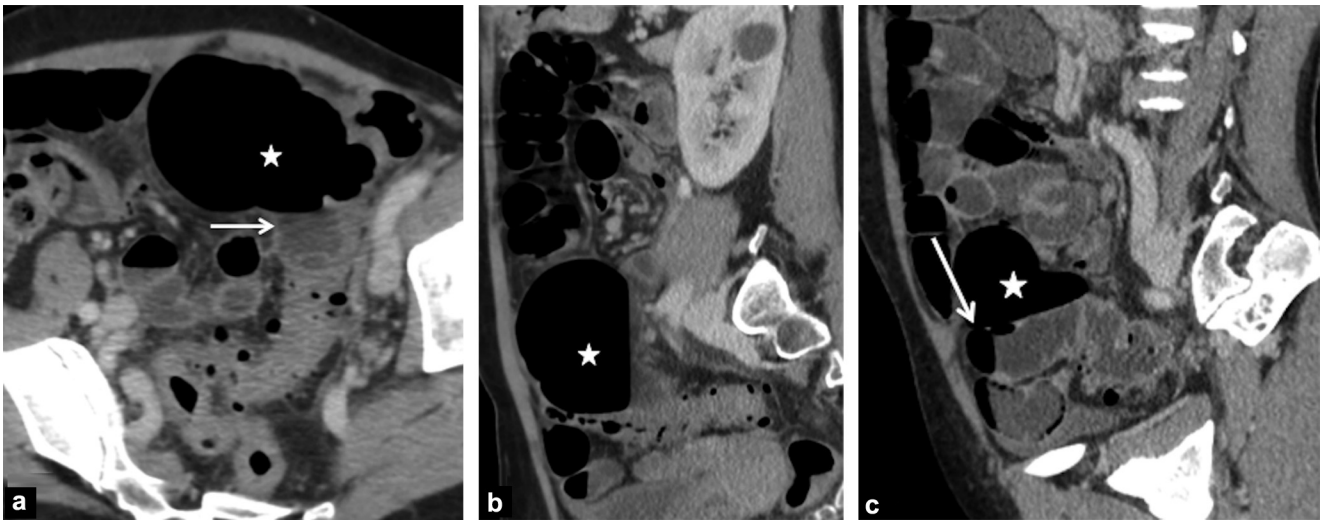


Figure 6. Diverticulitis with a giant diverticulum mimicking a perisigmoid abscess: a, b: axial and sagittal slices: image of air content (star), with an air-fluid level (arrow), attached to the sigmoid colon; c: sagittal slice: after antibiotic treatment air persists (star) communicating with the lumen of the sigmoid colon (arrow).

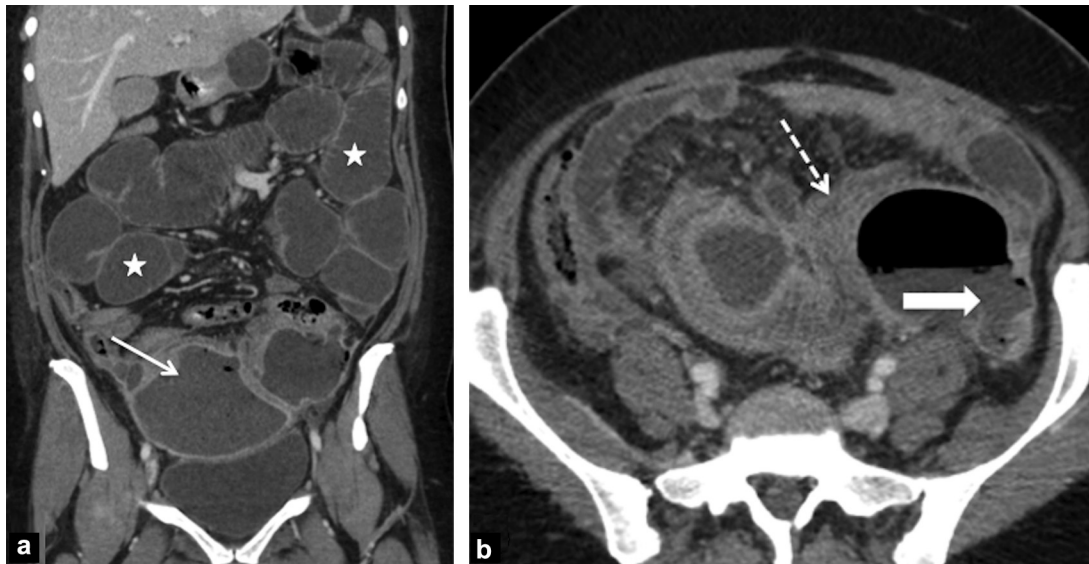


Figure 7. Perforated sigmoid diverticulitis on the mesenteric side complicated by peritonitis and occlusion of the small intestine: a, b: coronal and axial slices: perforated sigmoid diverticulitis (thick arrow), complicated by voluminous collections (thin arrow), reactive ileitis (dotted arrow), and distended loops of small intestine (stars).

infiltration of the adjacent fat. Focal thickening of the wall of the colon or parietal peritoneum can be observed [43,44].

Idiopathic segmental infarction of the greater omentum predominantly occurs on the right side. It has the same signs and symptoms as appendicitis but is more widespread [45].

Differentiating between cholecystitis and transverse diverticulitis where infiltration of the pericolic fat extends into the gallbladder bed is often difficult (Fig. 5). Ultrasound examination of the gallbladder can often correctly indicate the diagnosis (gallbladder lithiasis with a thickened flaky wall).

Differentiating between pelvic appendicitis and diverticulitis of the sigmoid colon is sometimes complicated in CT images, due to locoregional infiltration. A water-soluble

contrast enema and ultrasound (transvaginal in women) often helps straighten out the diagnosis.

Differential diagnoses for a diverticulum: colonic pseudodiverticulitis

The prevalence of jejunio-ileal diverticula is 0.6 to 2.3%. These single or multiple pseudodiverticula, located on the mesenteric border of the intestine, are large and numerous in the jejunum and small and uncommon in the ileum. Diverticular perforation is uncommon, and because of their topography on the mesenteric border, the perforation is usually covered [46].

CT signs of diverticulitis of the small intestine are not specific: a diverticulum with a thickened wall, associated

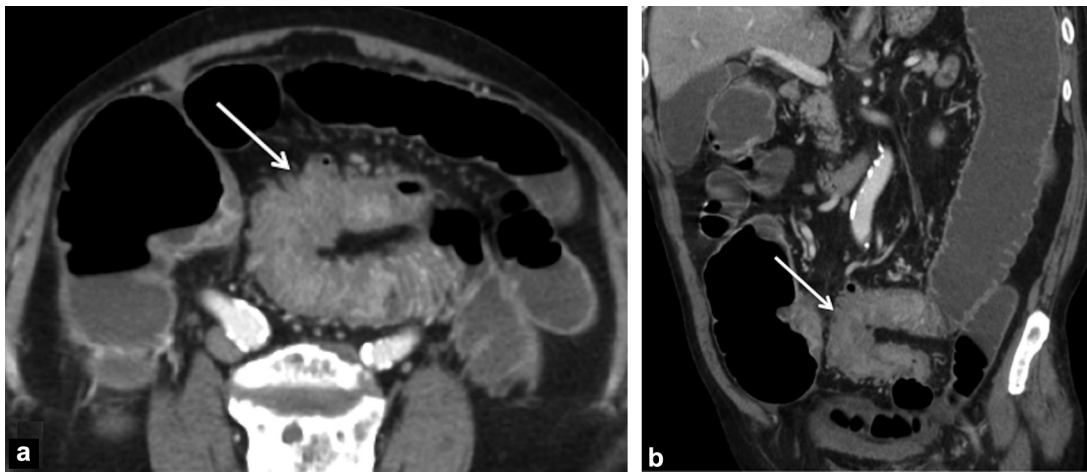


Figure 8. Colonic occlusion due to stenosis related to recurrent episodes of diverticulitis: a, b: axial and coronal slices: colonic distension upstream of circumferential thickening of the wall of the sigmoid colon, with diverticula.

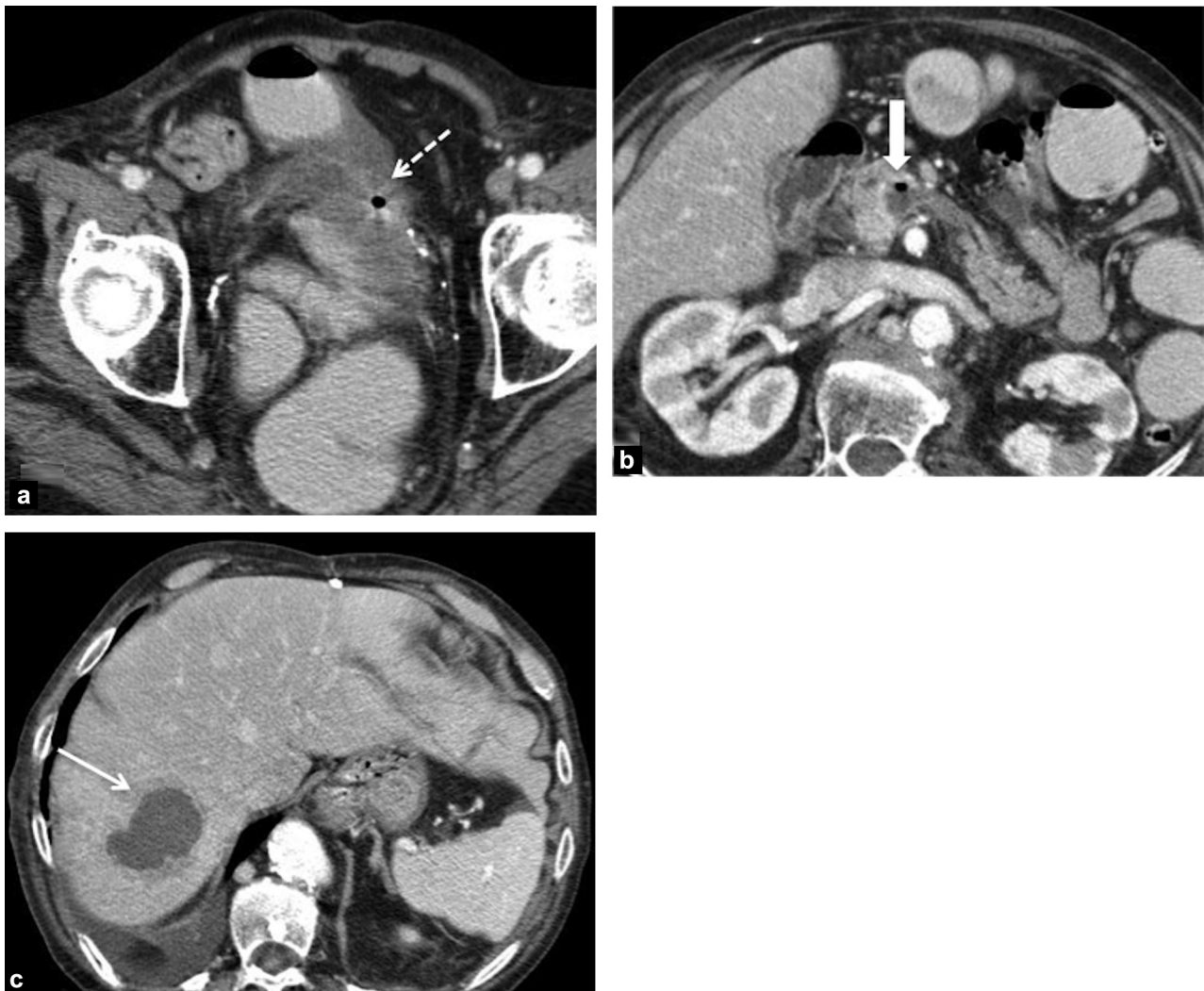


Figure 9. Sigmoid diverticulitis complicated by a liver abscess and pylephlebitis: a: axial slice: sigmoid diverticulitis (dotted arrow); b: axial slice: thrombosis and air in the lumen of the mesenteric vein (thick arrow); c: axial slice: liver abscess (arrow).

with inflammation of the peridiverticular fat. Its differential diagnosis with colon diverticulitis is based on attachment of the diverticulum to the small intestine and not to the colon. Errors are often due to the absence of opacification of the colon.

Differential diagnoses for thickening of the wall of the colon

Infected or perforated inflammatory colon cancer

Colon cancer can become secondarily infected and simulate sigmoid diverticulitis, especially since the prevalence of diverticulosis explains its frequent association with sigmoid cancer (Fig. 10).

CT is of limited use for differentiating diverticulitis from inflammatory or perforated colon cancer. In the literature,

the most specific signs of neoplasia are the presence of pericolic lymph nodes, a sharp transition zone and parietal thickening of more than 1 cm. On the other hand, thickening of the wall of the colon extending for more than 10 cm, a progressive transition to the normal wall, and parietal thickness of less than 1 cm are signs suggesting diverticulitis [47,48]. The association of colonic neoplasia with upstream ischaemic colitis makes diagnosis with CT even more difficult [49]. In addition, there are pseudotumour forms of diverticulitis (Fig. 11) and peritoneal carcinomatosis which form a sheath around the colon mimicking colonic diverticulitis (Fig. 12). Colon cancer is the essential differential diagnosis for colonic diverticulitis and should be systematically sought by colonoscopy or CT colonography, at a time other than during an acute episode [30,31].

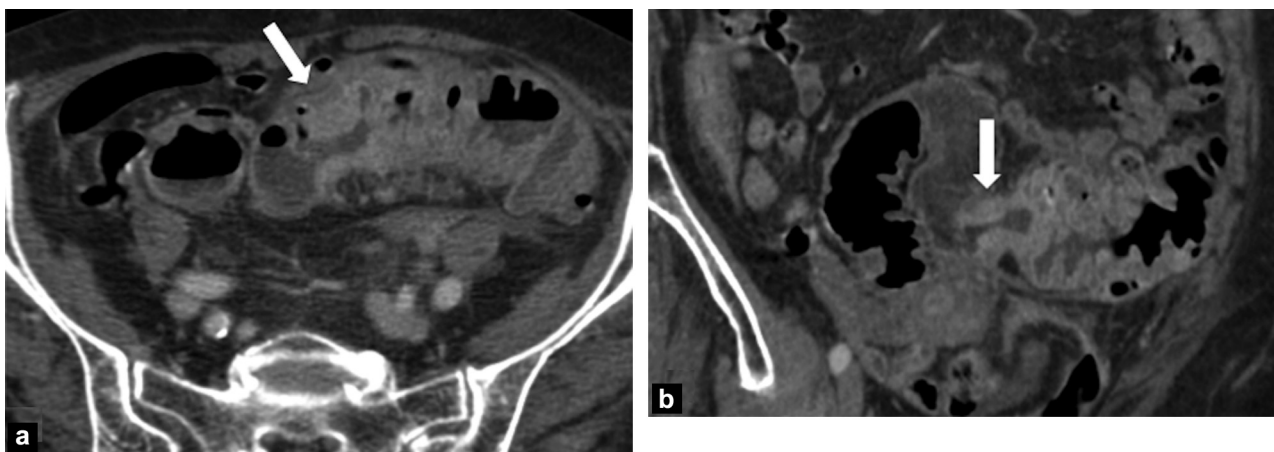


Figure 10. Colon cancer developed on sigmoid diverticulosis: a, b: axial and coronal slices: circumferential tumour thickening with an acute connection (arrow) downstream of sigmoid diverticulosis.



Figure 11. Pseudotumoral sigmoid diverticulitis: a: axial slice: considerable circumferential stenosing thickening of the wall of the sigmoid colon (thick arrows), associated with diverticula and infiltration of the pericolic fat. Ureter with a thickened wall near the colon (thin arrow); b: coronal slice: left obstructive hydronephrosis due to inflamed stenosis.

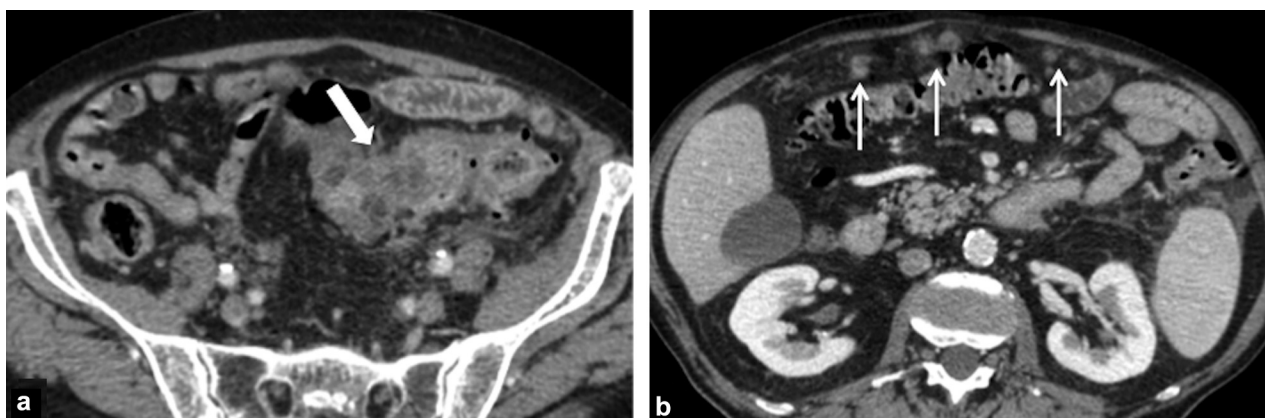


Figure 12. Peritoneal carcinomatosis mimicking sigmoid diverticulitis: a: axial slice: thickening of the wall of the sigmoid colon resulting from peritoneal carcinomatosis deposits (thick arrow); b: axial slice: peritoneal carcinomatosis with a large number of peritoneal tissue nodules of the greater omentum (arrows).

Infectious and ischaemic colitis

Infectious colitis can mimic diverticulitis, clinically. Thickening of the colon wall is often in layers, with considerable mucosal hyperaemia and marked submucosal oedema.

Ischaemic colitis occurs in elderly or younger patients with vasculitis. When there is no vasculitis, the usual areas are the splenic flexure, the transverse colon and the rectosigmoid junction. The diagnosis should be considered where there is segmental thickening of the wall of the colon. Infiltration of the pericolic fat is inconsistent (two thirds of cases).

CT is the most effective examination technique, but the signs are not specific. Diagnosis is achieved with certainty by taking into account the clinical context, CT data, the results of stool culture and colonoscopy.

Appendicitis: misleading forms

Simple appendicitis is defined in imaging by the presence of an appendix with a diameter of more than 6 mm, combined with inflammation of the peripheral fat [2,3,5]. The contents of the appendix vary: they may be liquid, stercoraceous or gaseous. The presence of gas in the appendix is found in 20% of cases of appendicitis, and does not exclude the diagnosis of appendicitis [26]. Because of their therapeutic implications, it is important to be aware of the topographic variations and the different complications of appendicitis, the presentation of which in imaging is sometimes misleading.

Particular forms and anatomical variants

Particular forms

Appendiceal stump appendicitis [50] (Fig. 13): invagination of the base of the appendix into the caecum can be the reason for incomplete appendectomy and may be responsible for recurrence of appendicitis.

Anatomical variants: general points

The clinical presentation and complications of acute appendicitis depend on the topography of the appendix.

Hypoplasia (or agenesis), duplication and congenital diverticula of the appendix are unusual. The first step in imaging to find the appendix is to locate the caecum, the position of which can vary. Diagnosis is therefore sometimes difficult with ultrasound, particularly with ectopic appendicitis, for which the use of CT is essential. With CT, the caecum is located by following the rectum to the right colon and finding the ileocaecal valve, perhaps being aided by its fat component. Two features, which can occur together, explain the variability in position of the appendix [51,52]:

- variation in the length or position of the appendix relative to an orthotopic caecum;
- variation in the position of the appendix caused by a heterotopic caecum (lack of attachment of the right fascia of Toldt or abnormal migration of the caecum).

Variation in the length or position of the appendix relative to an orthotopic caecum

The appendix is located 2 cm below the ileocaecal junction, where the taeniae coli converge. Its length is variable, from 8 to 10 cm up to 20 cm [53].

Variation in position

Many positions relative to the caecum have been recorded. The appendix can be pelvic, mesocolic (between loops of the small intestine in the periumbilical region), subhepatic, in an inguinal hernia (Amyand's hernia), or more rarely in a Spigelian hernia (Fig. 14). Mesocolic appendicitis more frequently appears as a febrile occlusion. The two main differential diagnoses for it are sigmoid diverticulitis perforated on the anti-mesosigmoid side and Meckel's diverticulitis. In women, pelvic appendicitis can mimic a gynaecological condition and may easily be complicated by an abscess in the pouch of Douglas (Fig. 15).

Variation in length

Mesocolic, subhepatic or pelvic appendicitis can also be related to a long appendix with the caecum in its normal place.

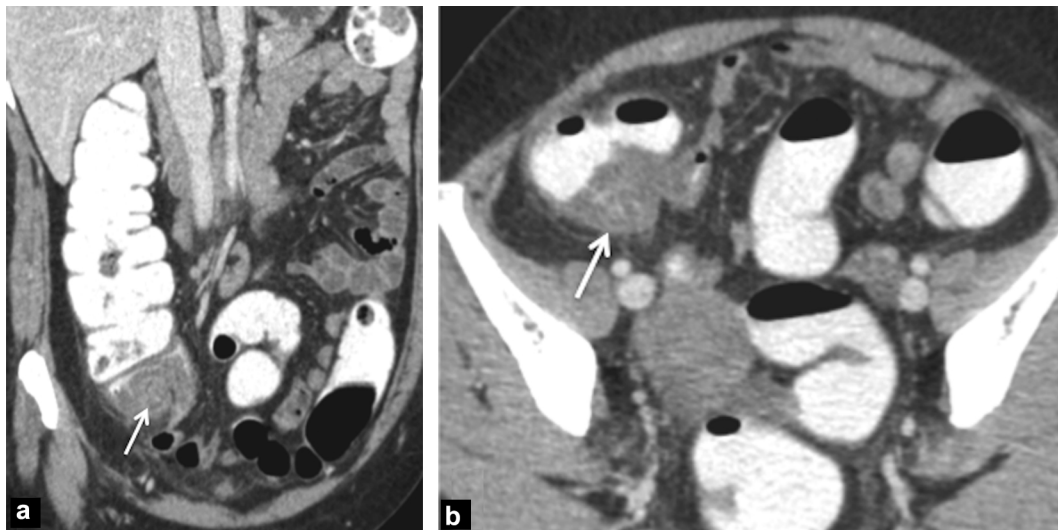


Figure 13. Appendicitis of an appendiceal stump (history of appendectomy 20 years before): a, b: coronal and axial slices: thickened appendiceal stump (arrow) associated with infiltration of the peripheral fat and thickening of the distal ileal loop.

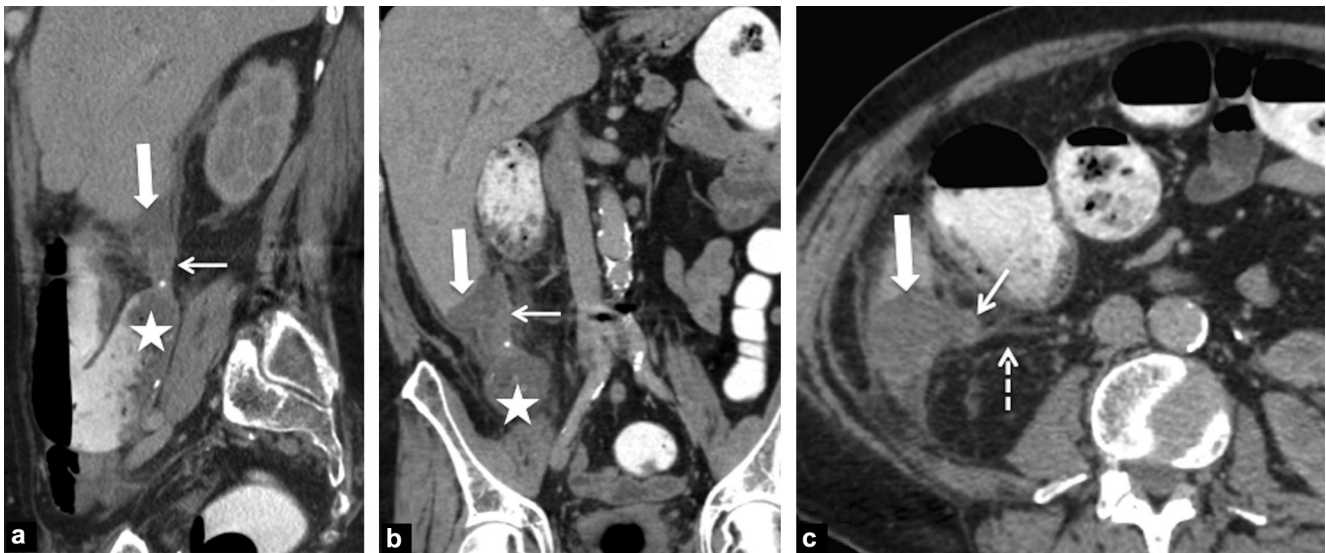


Figure 14. Retrocolic retrocaecal appendicitis in an incompletely rotated caecum: a, b: sagittal oblique reconstruction and coronal slice: retrocaecal appendicitis (thin arrow) with perforation at the tip of the appendix, with a subhepatic contiguity collection (thick arrow); incompletely rotated caecum (star); c: axial slice: retrocaecal appendicitis (white arrow), responsible for thickening of the right anterior pararenal fascia (dotted arrow); subhepatic collection (thick arrow).

Variation in position of the appendix due to a heterotopic caecum

Lack of attachment of the fascia of Toldt

Lack of attachment of the fascia of Toldt is responsible for a caecum that is mobile within the peritoneal cavity (complete in 11% and partial in 23% of the population). An appendix can be found in the mesocolic position due to abnormal length and/or the abnormal position of the caecum (Fig. 16).

Abnormal migration of the caecum

Abnormal migration of the caecum is due to the absence or interrupted rotation of the primitive intestinal loop during embryonic development (complete or incomplete common mesentery, situs inversus due to reversed rotation).

A complete common mesentery is due to interruption of intestinal rotation at 90°. The colon is thus on the left, the small intestine on the right and the caecum anterior-medial. The appendix is thus in a mesocolic position. The superior mesenteric artery is to the right of the superior mesenteric vein (Fig. 17).

An incomplete common mesentery is produced by rotation interrupted at 180°. The caecum has ascended to a subhepatic position.

Complications

Perforation

There are two types of perforation: a localised form seen as a lack of enhancement or a focal break in the continuity of

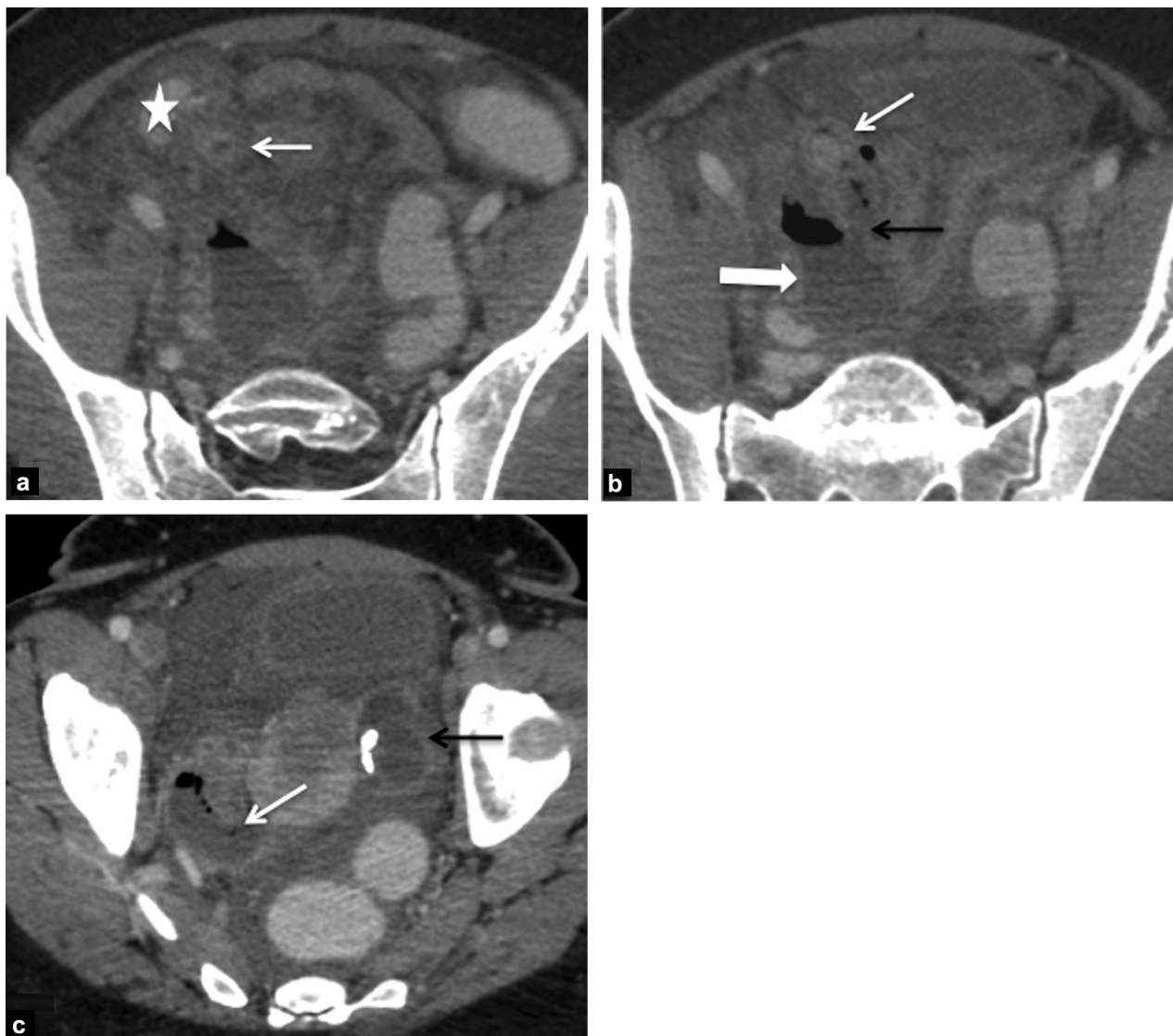


Figure 15. Perforated pelvic appendicitis complicated by an ovarian abscess: a: axial slice: pelvic appendicitis (thin arrow); caecum (star); b: axial slice: appendicitis containing a coprolith (thin arrow), perforated at the tip (black arrow) and complicated by an abscess (thick arrow); c: axial slice: right juxta-ovarian contiguity abscess (arrow). Note mature left ovarian teratoma (black arrow).

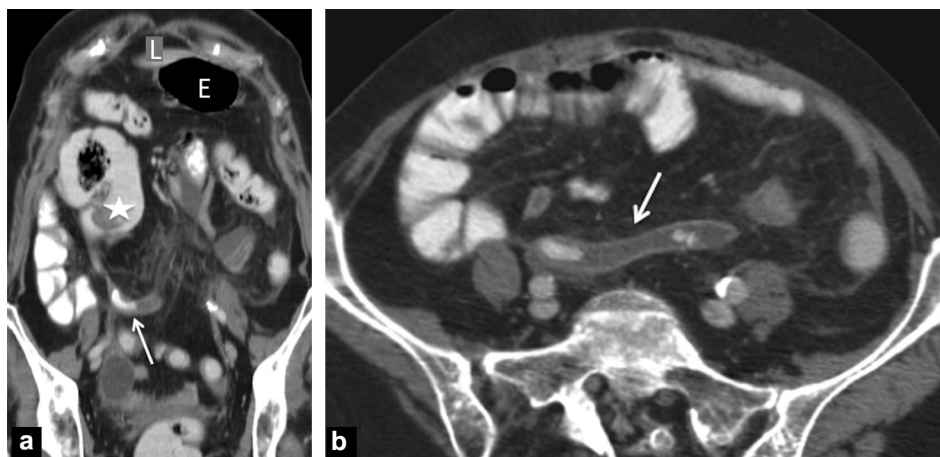


Figure 16. Mesocolic appendicitis with lack of attachment of the caecum and abnormal length: a: oblique coronal reconstruction: high caecum (star), appendix with an increased diameter containing coproliths (arrow). S: stomach; L: liver; b: axial slice: enlarged mesocolic appendix, the site of several coproliths, in an enlarged liquid-filled lumen (thin arrow).

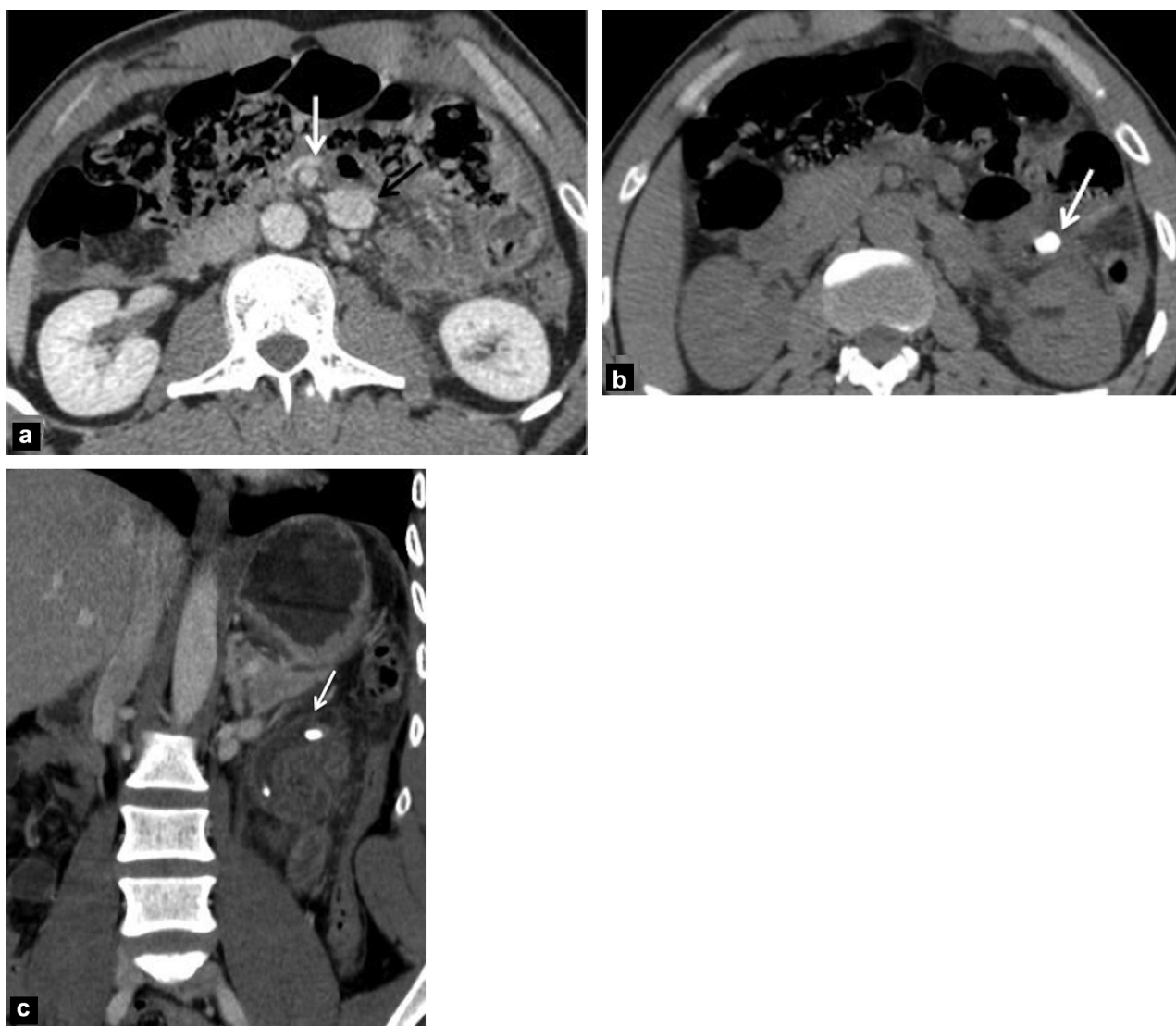


Figure 17. Left appendicitis with a complete common mesentery (kindly provided by Dr Yann Geffroy, Laveran Military Hospital, Marseille): a: axial slice: vascular malposition, with the superior mesenteric artery (white arrow) to the right of the superior mesenteric vein; b: axial slice: appendix situated in front of the left anterior pararenal fascia, identified on the non contrast-enhanced acquisition because of an intraluminal coprolith (arrow); c: coronal oblique slice: inflamed appendix (arrow) with the liquid-filled lumen containing coproliths.

the wall of the appendix; in the diffuse form, the appendix is no longer seen, sometimes resulting in a diagnostic error.

The most specific signs of perforation are an extra-digestive coprolith and/or extra-digestive gas bubbles [54,55]. A periappendiceal abscess, reflex ileus, or lack of parietal enhancement are not specific signs.

Local abscess formation

Periappendiceal abscess is the most common complication of perforation. It is most often located at the ileocaecal junction or in the pouch of Douglas (Fig. 18). A voluminous abscess can mask the perforated inflamed appendix.

Appendiceal mass is defined surgically as follows: an agglomerate of small intestinal loops centred on the inflamed appendix, in the absence of an abscess. It is a clinical term and should not be used in imaging reports because it could delay surgical treatment.

Febrile occlusion of the small intestine

Occlusion of the small intestine secondary to appendicitis is rare and often of mixed mechanical and functional origin. The loops of small intestine become impacted around the site of inflammation, and can mask the inflamed appendix (Fig. 18).

Pylephlebitis

This rare complication (0.05% for simple appendicitis and 0.3% for perforated appendicitis) is a septic thrombosis of the portal vein or one of its drainage veins [56,57]. In CT it appears as an endoluminal defect more or less associated with gas in the lumen of the ileocaecal-appendiceal veins, the superior mesenteric vein or portal vein. It is essential to diagnose it because it involves anticoagulation and antibiotic treatment for several weeks after the appendectomy (Fig. 19).

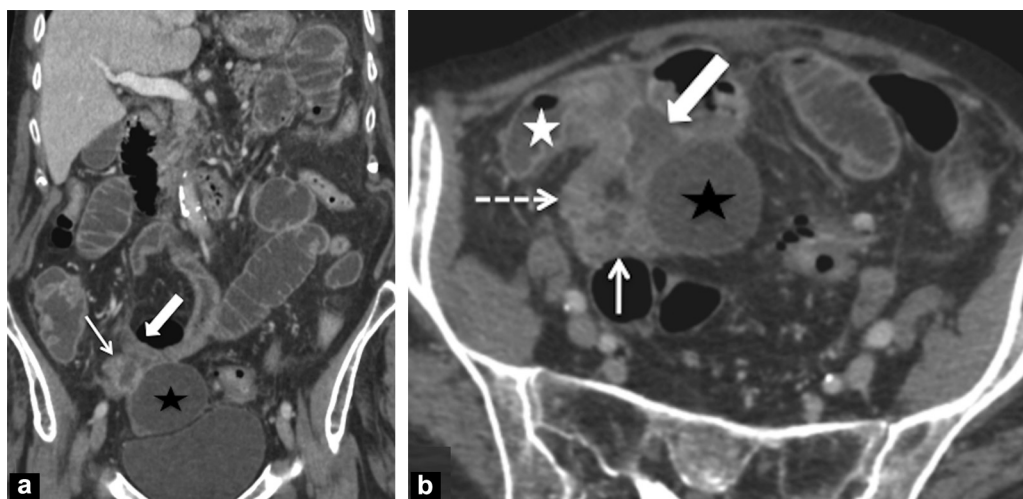


Figure 18. Febrile occlusion revealing pelvic appendicitis with perforation at the tip of the appendix with an abscess: a: coronal slice: dilatation of the loops of small intestine; one intestinal loop (thick arrow) is next to an abscess (thin arrow); ovarian cyst (black star); b: axial slice: thickened appendix (dotted arrow), perforated at its tip (solid arrow); effusion contiguous with the distal ileal loop (thick arrow); caecum (star).

Liver abscess

This is a complication which has become rare because of rapid management and appropriate antibiotic treatment. Liver abscesses have a portal origin [58]. They may be single or multiple, more often in the right lobe of the liver because of the direction of portal flow (the right branch of the portal vein in line with the flow). Any liver abscess should mean looking for a digestive cause (diverticulitis, appendicitis, colon cancer or chronic inflammatory disease of the intestine).

Differential diagnoses

Differential diagnoses for infiltration of the fat in the ileocaecal-appendiceal region

- Diverticulitis of the right colon: the most specific sign for this is the presence of an inflamed diverticulum (a diverticulum with a thickened wall, centred on a site of fat densification, with a lumen containing a coprolith) [34,35] (Fig. 4). A CT scan is also useful, showing a normal appendix;
- epiploic appendagitis, less common on the right, and infarction of the greater omentum, more frequent on the right: in both cases, the signs are very evocative and errors are rare;
- Meckel's diverticulitis: an inflammation of a residue of the embryonic omphalo-mesenteric duct connected to the distal loop of the ileum. To differentiate Meckel's diverticulitis from mesocolic appendicitis, the caecum and the attachment of the inflamed structure to the caecum or ileal loop must be located [47].

Differential diagnoses for thickening of the wall of the distal loop

- Inflammatory or infectious ileitis must be differentiated from reactive ileitis (Fig. 20);
- mesenteric lymphadenitis: in its primary forms this is an infectious lesion of the terminal ileum (often caused

by *Yersinia enterocolitica* or *Campylobacter*) associated with mesenteric lymphadenomegalies. In imaging, the lymphadenitis is seen as circumferential thickening of the terminal ileum and mesenteric lymphadenomegalies of up to 10 mm in their smallest diameter. It is essential to recognize it as its treatment is never surgical;

- Crohn's disease: this is still too often diagnosed when an appendectomy is performed or when subsequent complications occur [7]. It should be considered when imaging shows segmental involvement of the terminal ileum, in the form of circumferential, symmetrical thickening (Fig. 21) sometimes associated with images of transmural ulceration. The fat is often the site of sclerolipomatosis. Abscesses and (particularly entero-enteric) fistulae suggest the diagnosis [59] (Fig. 22). Involvement of the colon or appendix is classic and complicates differential diagnosis with appendicitis.

Differential diagnoses for thickening of the bottom of the caecum

It is often difficult to differentiate reactive caecitis resulting from appendicitis from a caecal tumour complicated by appendix retention. A water enema allows the caecal thickening to be explored more easily. In reactive caecitis, the thickening is fine, regular and focal, centred on the appendix (Fig. 20c).

Differential diagnoses for thickening of the wall of the appendix

It is often difficult to differentiate between pseudotumoral appendicitis and an appendiceal tumour (adenocarcinoma, mucocoele). Similarly, it is difficult to identify appendicitis where there is actinomycosis (Fig. 23).

The macroscopic definition of a mucocoele is the lumen of an appendix distended with mucus. Signs in imaging suggest that there is a large appendix due to dilatation of its lumen, thin, sometimes calcified walls without infiltration of peripheral fat. Appendicitis with retention has thick walls,

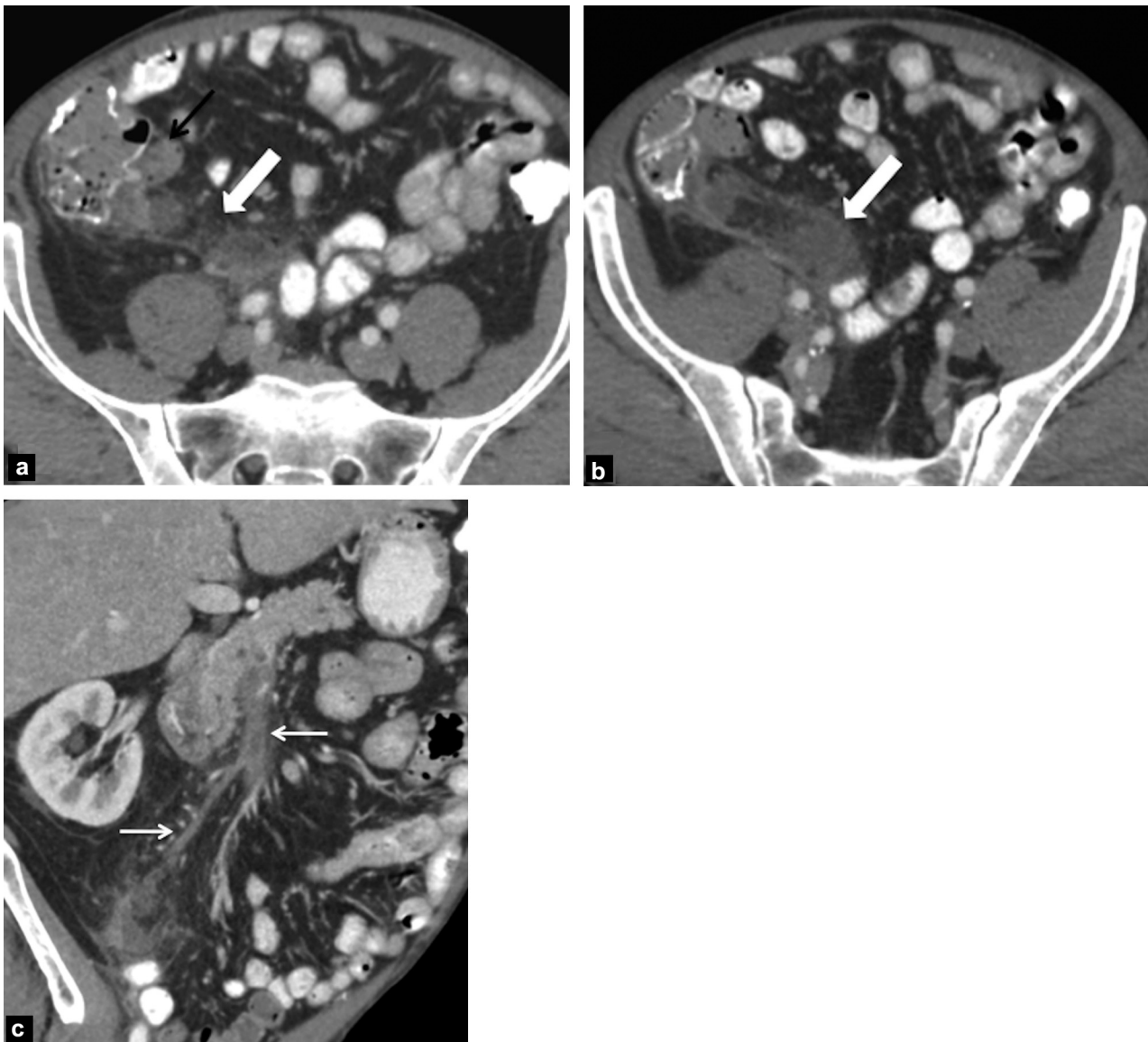


Figure 19. Perforated posterior ileocaecal appendicitis complicated by pylephlebitis: a, b: axial slices: perforated appendix with poorly defined, non-enhanced walls (thick arrows); c: axial slice: thrombus in the superior mesenteric vein (arrow).

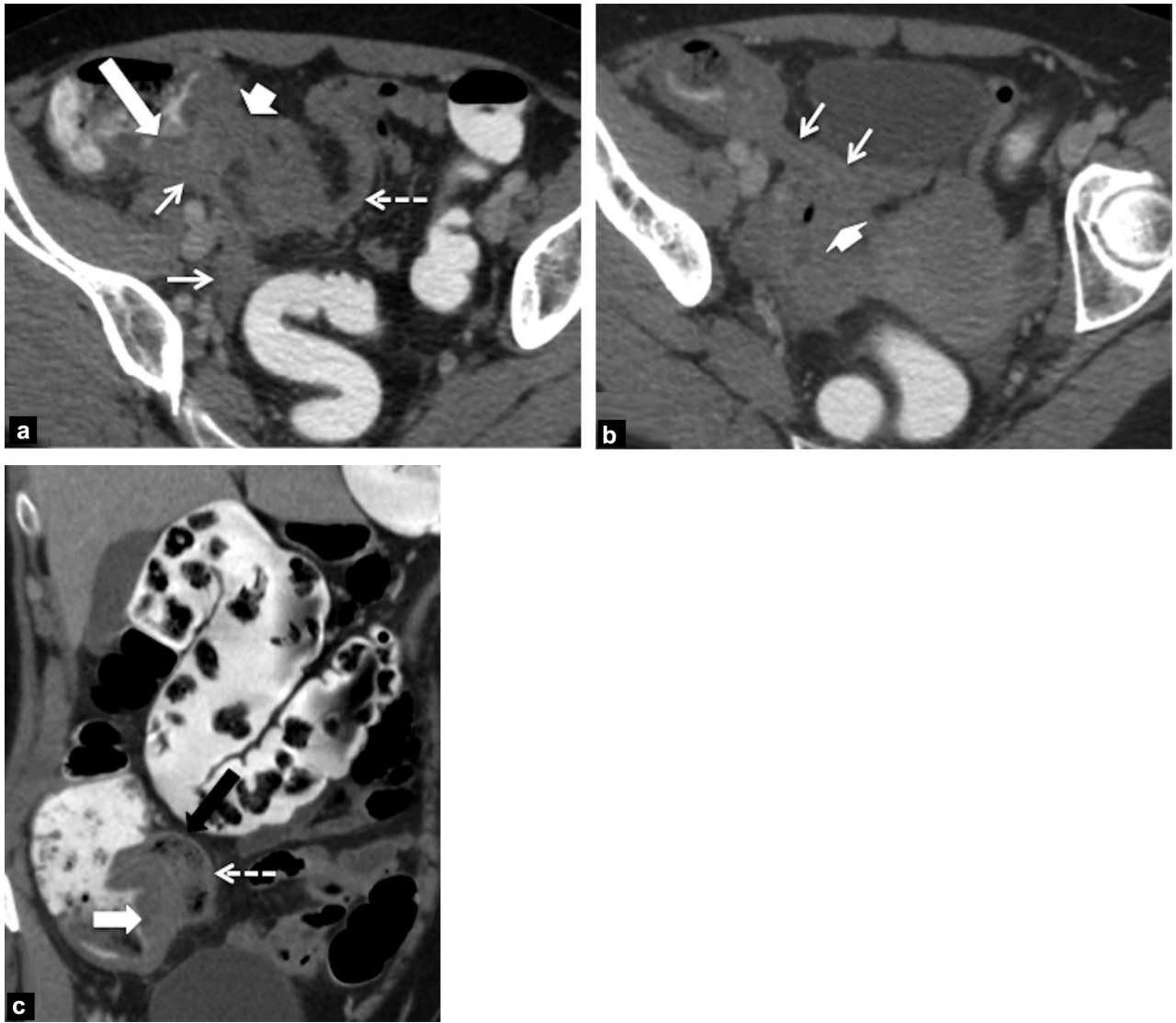


Figure 20. Appendicitis associated with caecitis and reactive terminal ileitis: a: axial slice: pelvic appendicitis (thin arrows) complicated by ileitis (short arrow) and thickening of the bottom of the caecum (thick arrow). The last ileal loop furthestmost from the ileocaecal junction is not inflamed (dotted arrow); b: axial slice: pelvic appendicitis (thin arrow), with perforation at the tip of the appendix, complicated by a poorly defined collection (thick arrow); c: coronal slice: reactive thickening of the bottom of the caecum (thick arrow) and the distal ileal loop (dotted arrow).

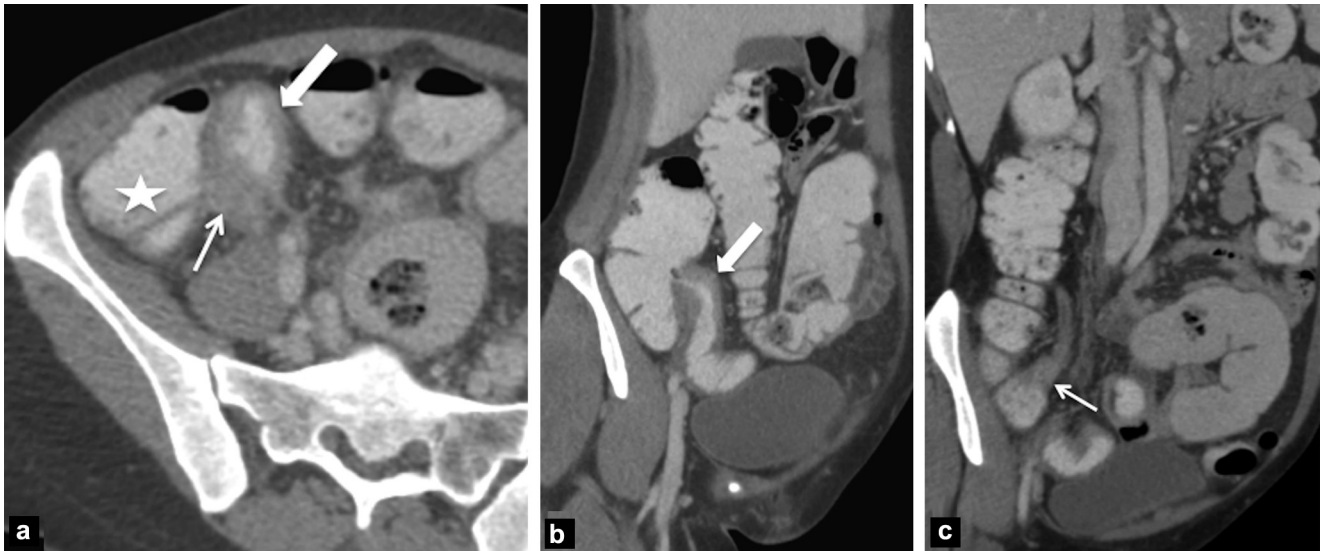


Figure 21. Crohn's disease revealed by an appendiceal condition: a: axial slice: circumferential thickening of the distal loop of the ileum (thick arrow) associated with a retro-ileal appendix with an enlarged diameter (thin arrow); caecum (star); b: coronal slice: terminal ileum with thickened wall (thick arrow); c: oblique coronal reconstruction: reactive inflamed appendix with increased diameter and thickened walls (thin arrow).

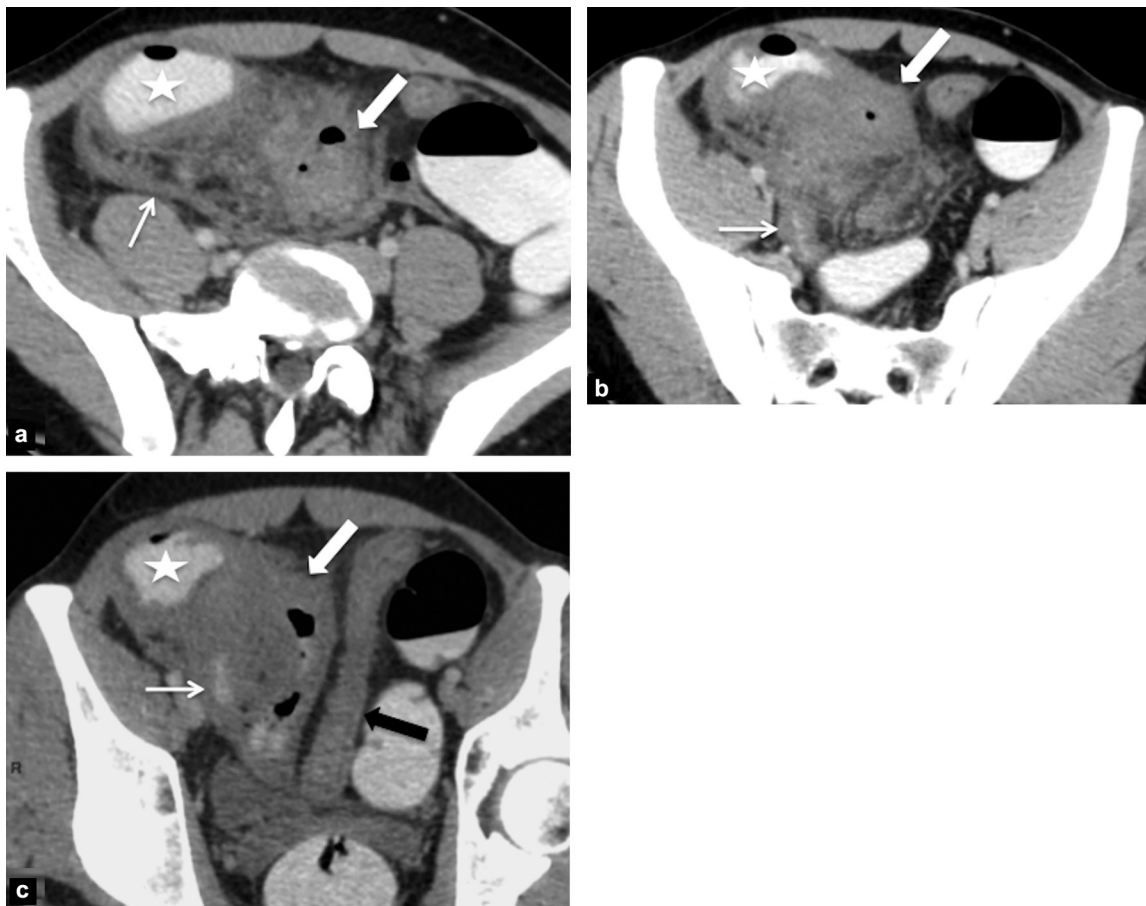


Figure 22. Crohn's disease revealed by an appendiceal condition: a: axial slice: infiltration of the fat of the ileocaecal junction and retroperitoneal fascia (thin arrow), associated with an air-fluid collection (abscess) (thick arrow); caecum (star); b, c: axial slices: thickening of the distal ileal loop (ileitis) (thick arrow) and the wall of the caecum (caecitis) (star); appendix with increased diameter and thickened walls (thin arrow). Extension of the ileitis beyond the ileocaecal-appendiceal junction (thick black arrow) is a good argument for primary ileitis rather than a reaction to appendicitis.

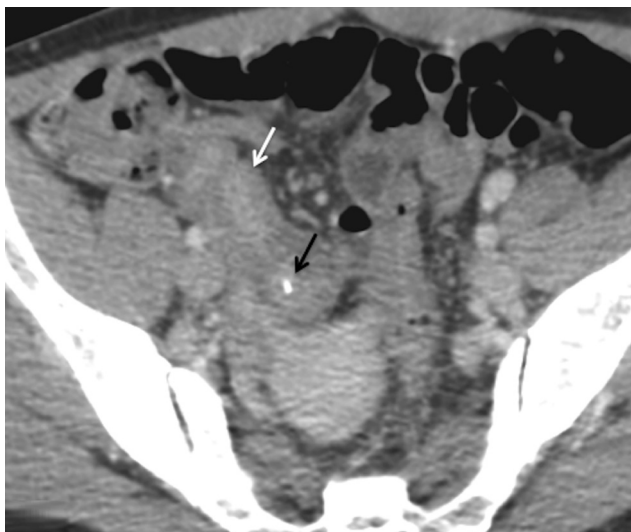


Figure 23. Pelvic appendiceal actinomycosis on a foreign body. Axial slice: pseudotumoral thickening of the appendix (white arrow) in the lumen of which there is a dense foreign body (black arrow).

infiltration of the periappendiceal fat and often a coprolith at its base [60].

Appendiceal adenocarcinoma is a rare tumour of the elderly. Evocative CT signs are heterogeneous thickening of the walls of the appendix associated with lymphadenomegalies [61] (Fig. 24).

Conclusion

Appendicitis and diverticulitis are conditions with well-known appearances in imaging. Nevertheless, knowledge of the anatomical variants and complications is essential to avoid wrong diagnosis when the presentation is atypical.

TAKE-HOME MESSAGES

Techniques

- Ultrasound is the first-line examination in cases of suspected appendicitis.
- CT images for febrile acute abdomen must cover the entire abdominopelvic cavity and be performed with injection of a contrast agent unless there is a contraindication.
- A CT scan for suspected diverticulitis must be undertaken within 72 hours of the clinical diagnosis.
- CT is not very reliable for differentiating diverticulitis from an inflammatory or perforated colon cancer.

Diverticulitis

- Owing to its topography, right or left diverticulitis can have retroperitoneal expression.
- An inflamed diverticulum is the preserve of right diverticulitis. This is a very specific but not very sensitive sign.

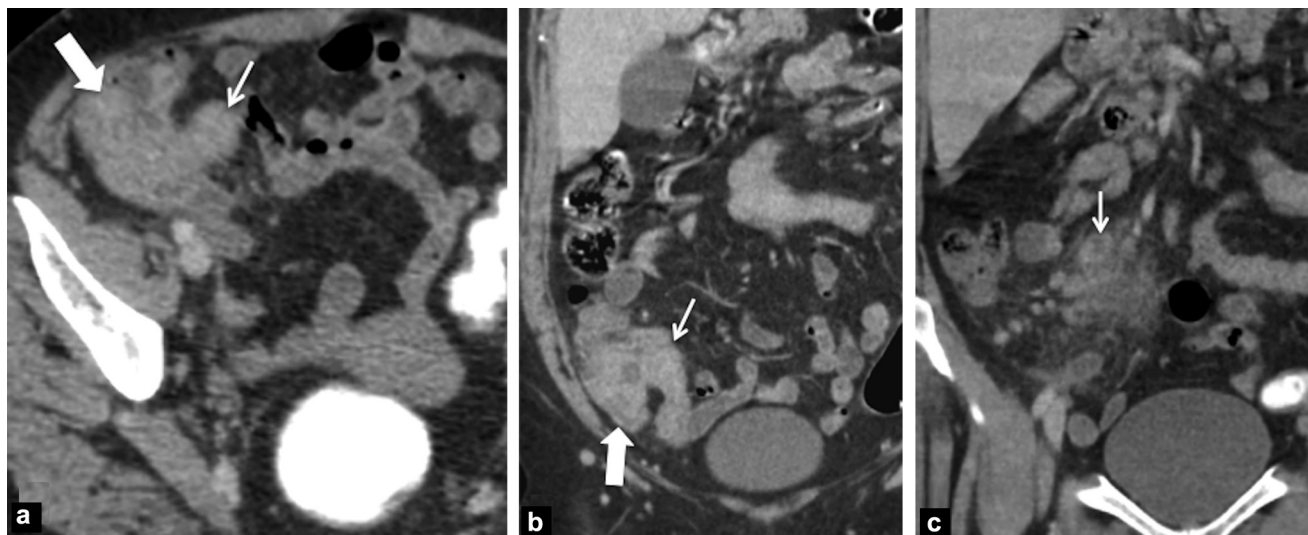


Figure 24. Adenocarcinoma of the appendix and bottom of the caecum revealed by appendiceal symptoms: a, b: axial and coronal slices: thickening of the tissue of the bottom of the caecum (thick arrow) and the appendix, the lumen of which is not distended (thin arrow); c: coronal slice: lymphadenomegalies along the caeco-appendiceal vascular pedicle, some of which are necrotic (arrow).

Appendicitis

- "Appendiceal mass" is a surgical term and should not be used in imaging reports.
- Crohn's disease should be considered when there is a pseudo-appendiceal condition associated with an ileal segmental lesion.
- If there is febrile occlusion of the small intestine, you should look for appendicitis or diverticulitis.
- A digestive cause (diverticulitis, appendicitis, colon cancer, chronic inflammatory disease of the intestine) should be sought for any liver abscess.

Clinical case

Here are some contrast-enhanced CT images (Fig. 25).

Questions

1. What abnormalities can you see?
2. Could the diagnosis be diverticulitis of the sigmoid colon?
3. What final diagnosis would you put forward?

Answers

1. On the CT image, there is thickening of the walls of the sigmoid colon associated with infiltration of the pericolic

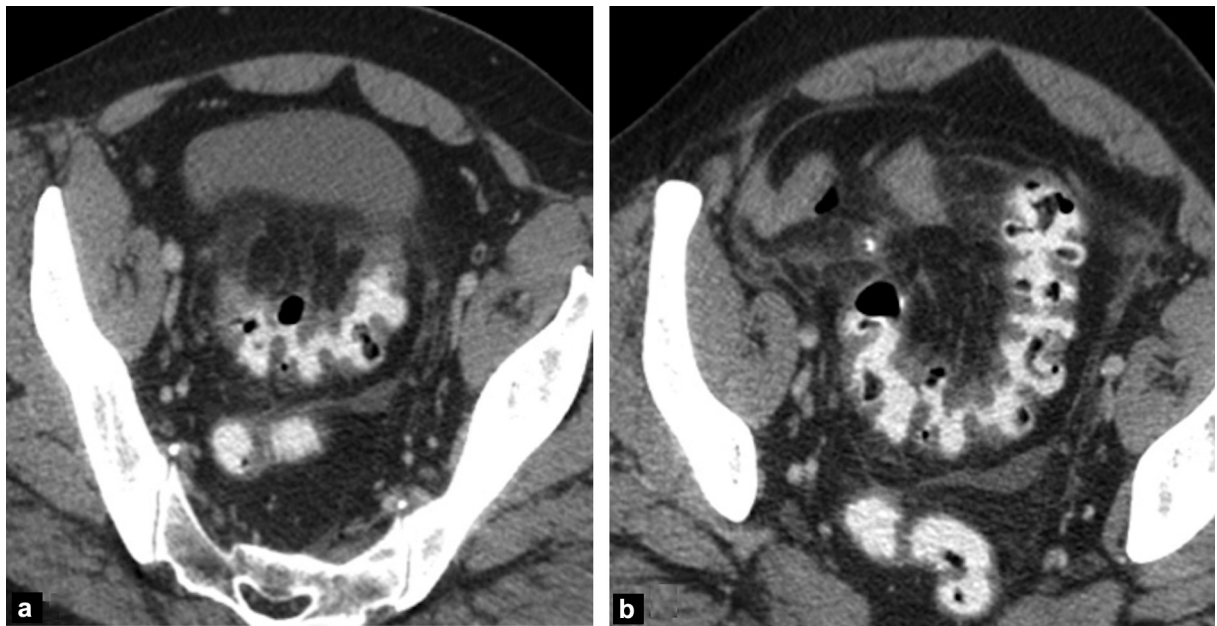


Figure 25. Contrast-enhanced abdominopelvic CT scan.

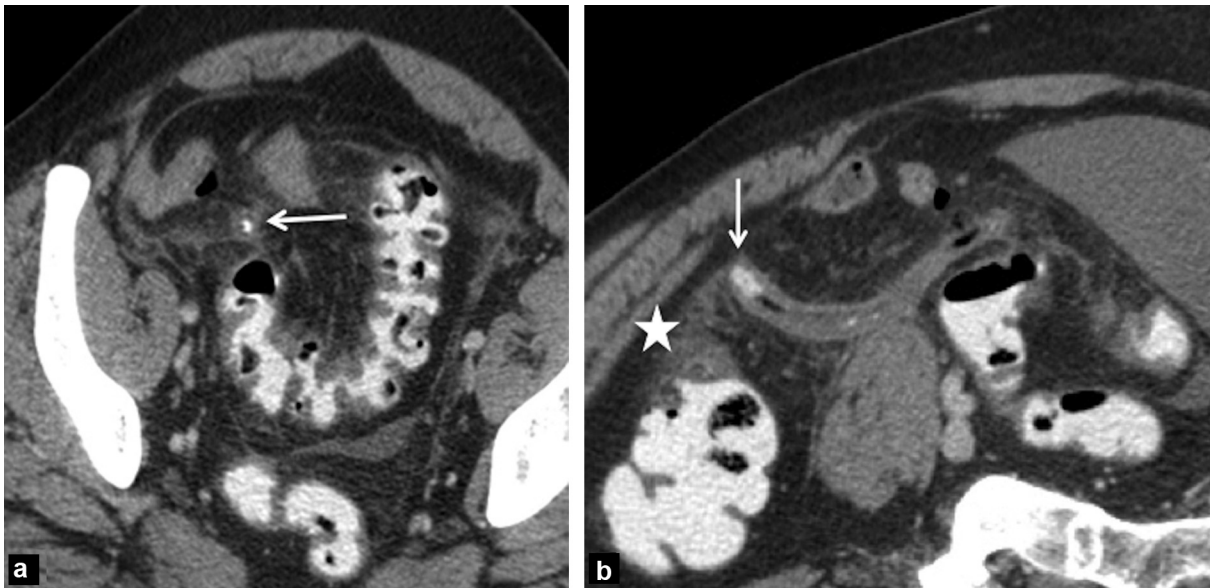


Figure 26. Contrast enhanced CT from abdomen to pelvis (with arrows).

fat. There is also a rounded addition image contiguous with the colon, with a calcified image in the centre which could be a coprolith (Fig. 26a): this image suggests an inflamed diverticulum.

2. It could certainly be diverticulitis of the sigmoid colon, but in this case, the addition image would be an inflamed diverticulum. However, inflamed diverticula are rare in the sigmoid colon.
3. The final diagnosis is pelvic appendicitis (appendix with thickened walls and distended lumen, surrounded by infiltration of the periappendiceal fat) (Fig. 26b) (arrow), complicated by inflammation of the sigmoid colon (star) by contiguity.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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