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Mechanical occlusions: Diagnostic traps and key points of the report

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KEYWORDS
Mechanical occlusion; Computed tomography; CT report

Abstract Management of mechanical occlusion, particularly of the small intestine, has altered considerably over recent years, with a change of paradigm and the indication for surgery depending on the cause of the occlusion and any signs of entrapment or strangulation. It is therefore important today to make a positive diagnosis of mechanical occlusion, to assess its degree, its location and its cause, and to look for signs of entrapment and strangulation. Only computer tomography can provide the answers to these different questions. The aim of this paper is to provide a reminder of the CT signs that enable us to confirm diagnosis of the various aspects of mechanical occlusion of the stomach and duodenum, small intestine or colon, to emphasize and illustrate the diagnostic traps in CT and to set out the key points of a CT report of mechanical occlusion.

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Acute intestinal obstruction is a condition defined by a sudden, complete halt in the transit of material and gases. It accounts for between 10 and 20% of acute abdominal pain in adults and nearly 25% of surgical admissions for acute abdomen. Sixty-five to seventy-five percent of mechanical occlusions occur in the small intestine with between 25 and 35% in the colon, while gastroduodenal occlusions are much less common, making up 1–2% [1].

The key questions to ask when occlusion is suspected were set out by Mondor more than fifty years ago [2] and revised by Herlinger and Maglinte [3] over twenty years ago, and their objectives are as follows:

• to confirm the diagnosis of mechanical occlusion and differentiate it from ileus;
• to assess the degree of the mechanical occlusion;

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• to determine the site of the mechanical occlusion: the stomach, duodenum, small intestine or colon, and the precise location of the obstruction within these different digestive segments;
• to determine the cause of the mechanical occlusion;
• to look for signs of closed loop obstruction (entrapment) and strangulation;
• to allow appropriate treatment, which may be medical or surgical by laparotomy or laparoscopy.

Clinical examination often fails to diagnose these various aspects of occlusion for the following reasons: the intensity of abdominal pain is variable in mechanical occlusion, transit may not be stopped in high occlusions, vomiting is not specific and is found in most acute abdominal conditions, and the fever and tachycardia which suggest strangulation are often absent, even in cases of actual ischaemia.

Because of the inadequacies of clinical examination, imaging has been widely studied and used for the diagnosis and evaluation of mechanical occlusion.

The four imaging examinations theoretically useful for diagnosing occlusion are a plain abdominal X-ray, ultrasound, CT and MRI.

A plain abdominal X-ray was for a long time an important examination in suspected occlusion. However, it gives a number of false negatives, particularly for severe occlusions when the content of the intestinal loops is exclusively liquid, and does not allow the causes, beyond rare cases of biliary ileus, or the complications of mechanical occlusion to be diagnosed. The report of the Haute Autorité de Santé (HAS—French National Authority for Health) [4] clearly concluded that there is no indication for a plain abdominal X-ray where occlusion is suspected and recommends a CT scan as the first line of investigation.

Ultrasound is used for diagnosing mechanical obstruction in children, especially for investigating acute intussusception, but other than in highly specialised departments and as part of evaluation, it is not indicated as the first-line examination where there is a suspicion of mechanical obstruction in adults. It might possibly be performed as a second line of investigation to clarify certain images seen with CT (Fig. 1).

MRI, particularly coronal slices and T2-weighted sequences, has shown promising results in diagnosis of mechanical obstruction, but with certainly poorer performance than CT. Even though MRI has the advantage of not...
exposing the patient to X-rays, it has no place at present in clinical strategies apart from academic work.

CT is thus the principal examination in a case of suspected mechanical occlusion, and we will see in this paper the key points which should be part of a CT report and the major traps in the various stages of diagnosis. The images chosen to illustrate this paper will mainly concentrate on these diagnostic traps.

**Indications**

The request for an examination should systematically include the clinician’s diagnostic hypothesis, at least concerning the presence of a mechanical obstruction, its site in the small intestine or colon and its cause.

The prime site for mechanical occlusion is the small intestine and its principal cause is the presence of an adhesion band. The vast majority of these bands (over 95%) are classically postoperative in origin, but it should be noted that certain studies [5] have described almost 10% of mechanical obstructions of the small intestine as due to bands or adhesions where there has been no history of surgery; these bands causing occlusion appear de novo, complicate an abdominal inflammatory or infectious episode or are congenital. It is therefore essential for the examination request to specify any history of abdominal surgery, with the type performed, since the risk of an adhesion band and particularly the risk of a band causing an occlusion is higher where there is a history of colon or gynaecological surgery.

**Technique**

With the development of volume rendering, the scanning technique used in suspected occlusion has now been standardised: millimetre or sub-millimetre thin slice acquisition using iterative reconstruction to reduce exposure to X-rays and reconstruction in the three spatial planes — axial, coronal and sagittal.

An intravenous injection is generally recommended. If it is contraindicated (renal insufficiency, allergy), this should be clearly stated in the examination request and the CT scan will be less efficient for detecting signs of strangulation, although non-enhanced hyperdensity of the intestinal wall is a good sign and is useful in these conditions.

Where there is suspected mechanical obstruction, an oral contrast agent adds an additional burden to the examination and is often poorly tolerated; its advantage is that it allows the degree of occlusion to be evaluated and could be recommended in early follow-up of an occlusion that does not improve with medical treatment.

**Results**

The results, obviously the main component of the report, should be addressed at each stage of confirming the positive diagnosis, degree, location, cause, complication and therapeutic impact. In this paper, the CT appearance, CT traps and key elements which should appear in the report will be discussed in detail for each diagnostic stage.

**Positive diagnosis**

**CT appearance**

Diagnosis of mechanical occlusion is based on the existence of intestinal dilatation upstream of the obstacle and collapse downstream. In the context of mechanical obstruction of the small intestine, the latter is considered to be dilated when its diameter is greater than 2.5 cm, whereas the colon is considered to be dilated in the context of mechanical occlusion when its diameter is greater than 8 cm.

Identifying the transition zone is the crucial aspect in diagnosing mechanical occlusion: to do this, the zone of abrupt change in size must be found between the dilated proximal intestine and the collapsed distal intestine.

The third (less important) sign described in mechanical occlusion of the small intestine is the presence of particulate and other matter in the small intestine, called the “small bowel faeces sign”, which facilitates identification of the transition zone [6], since it is found immediately upstream of it.

**CT traps**

Dilatation of the loops of the small intestine is obviously not specific to mechanical obstruction of the small bowel as it occurs by definition in paralytic ileus; on the other hand, it is a very sensitive sign for diagnosis of mechanical occlusion of the small intestine. Strangulation can develop rapidly, however, and the dilatation may be limited to one or two intestinal loops and be relatively moderate, giving the appearance of occlusion with a hyperalgesic flat abdomen, often with lack of enhancement of the intestinal wall, indicating ischaemia (Fig. 2).

While very suggestive, the presence of a faeces sign is not specific: it is only taken into account for our purposes when the particulate feculent material occurs in a loop measuring more than 2.5 cm in diameter, since it may be present in normal sized loops, especially in patients with cystic fibrosis or infectious or metabolic enteropathy.

The sign should not be confused with a bezoar, which is characterised by a well-defined mass, in clumps, with gas bubbles, corresponding to the accumulation of food debris responsible for occlusion.

In mechanical occlusion secondary to multiple adhesions, which are by definition short and thick as opposed to an adhesive band which is single, long and thin, the transition zone may be difficult to identify [7], since there are several of them, and diagnosis is then based on the abnormal angulation appearance of the intestinal loops [8].

As far as mechanical occlusion of the colon is concerned, false negatives can be produced by a colon cancer causing partial obstruction and/or the presence of colonic segments downstream remaining normally aerated or slightly dilated. False positives can arise due to pseudo-obstruction of the colon, with dilatation of the ascending and transverse colon but no dilatation of the left colon, resulting in wrongly diagnosing mechanical occlusion of the colon with an obstruction at the splenic flexure. In a retrospective study of eight cases of pseudo-obstruction of the colon, the transition zone was indeed located in six patients at the splenic flexure, in one patient in the middle part of the transverse colon and in one patient in the middle part of the left colon [1,9].
Key elements of the report  
It is certainly important therefore to state the positive diagnosis of mechanical obstruction in a CT report, but also to note the maximum dilatation of the small intestine or colon, to identify the presence of a small bowel faeces sign and describe the number and location of the transition zone or zones.

Diagnosing the location  
CT appearance  
It is relatively easy to diagnose the location in mechanical occlusions of the colon by following the colon backwards from the rectum to the caecum to find the transition zone between the collapsed distal colon and the dilated proximal colon.  
The site of mechanical occlusion of the small intestine is more difficult to identify.  
A pointer for distinguishing a jejunal occlusion from occlusion of the ileum is to compare the length of small intestine dilated upstream with the section collapsed downstream. However, only precise identification of the transition zone or zones will reveal the exact site of the occlusion. It should be remembered that the course of the intestine can be followed using cine mode, from the duodenum for high small bowel occlusions or from the caecum for low small bowel occlusions. This mode of procedure followed on the console is now an essential tool in interpretation of a CT scan looking for mechanical occlusion.

CT traps  
Jejunal loops may not be dilated during mechanical occlusion when they are at a distance from the obstruction, when the obstruction is intermittent or low grade, or when ischaemia predominates with symptoms related more to the ischaemia than to the occlusion itself.

On the other hand, it should be noted that during acute intestinal obstruction, the classic topography of the intestinal loops is often modified and displacement of jejunal loops into the pelvis with ileal loops rising to the upper right quadrant is not uncommon; deducing the point of occlusion based on the site of transition within the abdominal quadrants may thus result in misinterpretation.

Points to include in the report  
The exact site of the occlusion should appear in the CT report; we must not be content simply to differentiate between mechanical obstruction of the small intestine or colon but should identify the precise site of the occlusion: the proximal jejunum, distal jejunum, proximal ileum, distal ileum or the segment of the caecum or colon, ascending colon, transverse colon, descending colon, sigmoid colon or rectum, and give the distance between the obstruction and the anal margin in low occlusions.

Diagnosing the degree  
CT appearance  
Differentiating between a high-grade occlusion and a low-grade occlusion where digestive material is passing downstream of the site of the occlusion in theory requires the use of an oral contrast agent and late slices.  
In clinical practice, an oral contrast agent is not usually given for a mechanical obstruction and the degree of occlusion is determined from the degree of collapse of the downstream loops and the caecum, and particularly from the ratio of the diameters of the upstream dilated loop and the collapsed downstream loop.

CT traps  
In clinical practice, the degree of occlusion is given inconsistently and it is certainly the ratio between the diameter of the dilated proximal intestine and the diameter of the
Mechanical stenosis, cholecystitis, ulceration, intussusception. Dilated schematically, due first the cancer, artery, intestine, stomach, pyloric, antropyloric, gastroduodenal adhesions, mesenteric arterioles, mesenteric cysts, or adenocarcinomas in the small or large intestine. 

Points to include in the report

The degree of occlusion should be part of the report, differentiating high grade from low-grade occlusions schematically, based on the ratio of the diameter of the dilated small intestine to the diameter of the collapsed small intestine downstream, because it is a factor predicting the success or failure of any medical treatment given [10, 11].

Diagnosing the cause

The causes of mechanical occlusion and their distribution in terms of frequency depend on whether the site of the occlusion is gastroduodenal, or in the small or large intestine.

Mechanical gastroduodenal occlusion [1]

The three main causes of gastroduodenal occlusion are malignant tumours, with antropyloric adenocarcinomas in first place, pyloric or duodenal stenosis following peptic ulceration, and gastric volvulus.

Other less common causes are superior mesenteric artery syndrome, Bouveret syndrome, postoperative gastric stenosis, especially after treatment of morbid obesity, pancreatitis, annular pancreas, bezoar and duodenoduodenal intussusception.

CT appearance

It is theoretically relatively easy to diagnose gastric cancer and gastric volvulus with CT. In the case of gastric cancer, there is considerable, often extensive, asymmetric, irregular thickening of the wall if the cancer is causing occlusion, but most gastric cancers do not result in occlusive symptoms.

In gastric volvulus, CT can differentiate between the two types, organoaxial and mesenteroaxial volvulus. In organoaxial volvulus, the stomach twists along its long axis and this is often associated with a paraoesophageal hernia, as the antropyloric region remains in the normal position. On the other hand, the less frequent mesenteroaxial form occurs when the stomach twists on its short axis with the antropyloric region being level with or above the gastro-oesophageal junction.

CT traps

The cause of a mechanical gastroduodenal occlusion is inconsistently diagnosed with CT in clinical practice because of the rarity of certain diagnoses. Nevertheless, the appearance of certain conditions, such as superior mesenteric artery syndrome with an abnormally small angle between the aorta and the superior mesenteric artery, Bouveret syndrome with a calculus impacted in the duodenum, or annular pancreas with pancreatic parenchyma both posterior and lateral to the second part of the duodenum, is pathognomonic for this condition.

In post-ulcerative stenosis, the stenosis is sometimes short, with parietal thickening which is sometimes difficult to identify in a CT scan, making the differential diagnosis between mechanical occlusion complicating a peptic ulcer and gastroparesis difficult [1]. Conversely, in a neoplastic stenosis, the thickening is sometimes symmetrical, making the differential diagnosis with a post-ulcerative stenosis difficult, and thus justifying an endoscopic examination (Fig. 3).

In volvulus, we should not be content with finding the stomach in an abnormally high position, which is also encountered in rolling hiatus hernia. We should follow the path of the stomach, the respective positions of the greater and lesser curvatures, the oesophago gastric junction and the pyloroduodenal junction, in order to confirm a diagnosis of volvulus and give its type.

**Figure 3.** Mechanical gastroduodenal occlusion due to an antropyloric neoplastic stenosis. Coronal (a) and sagittal (b) reconstructions show an antropyloric circumferential, short, tight stenosis responsible for upstream dilatation.
Key elements of the report
The cause of a gastroduodenal occlusion is obviously an essential item in the report since it has a direct impact on the type of management—laparotomy, laparoscopy, endoscopic dilatation—and its urgency, since what becomes of a mechanical gastroduodenal occlusion depends more on the cause of the obstruction than on the degree of gastric dilatation. There is a high risk of gastric ischaemia and perforation with peritonitis or mediastinitis in cases of gastric volvulus where management is delayed.

Occlusion of the small intestine
There are many causes of occlusion of the small intestine, classically differentiated into extrinsic lesions, intrinsic lesions with intestinal parietal involvement and intraluminal lesions [12].

Adhesive bands, other adhesions, and external and internal hernias predominate among extrinsic lesions. Intrinsic causes are dominated by tumours of the small intestine, and inflammatory and vascular lesions in ischaemia. Intraluminal causes are headed by intussusception and bezoars.

CT appearance
Adhesion bands and other adhesions are the principal cause of mechanical occlusion of the small intestine. While classic CT diagnosis used to be based on negative signs, i.e. the lack of mass or parietal thickening of the transition zone, there are now positive signs for adhesion bands, with the beak sign which was described more than 20 years ago [13,14], and the fat notch sign (Fig. 4), more recently described [15] but less used, although very specific, and corresponding to extraluminal compression of the digestive tract by the band.

These signs encountered with adhesion bands are not generally observed with multiple adhesions.

External hernia is a cause of mechanical occlusion of the small intestine which is decreasing and is usually easily diagnosed; the most frequent types are occlusions by femoral and inguinal hernias. Inguinal hernias occur above the inguinal ligament, which is a good anatomical landmark.

Direct inguinal hernias pass medial to the epigastric artery, while indirect hernias pass lateral to it. If the epigastric artery is not visible, the position of the hernia sac relative to the pubic tubercle is a useful pointer: a sac crossing the plane of the pubic tubercle medially indicates an indirect inguinal hernia, whereas when it does not cross this plane medially, the inguinal hernia is direct [16]. Femoral or crural hernias pass below the inguinal ligament, in immediate contact with the femoral vessels, anterior to the pectineus muscle and lateral and posterior to the pubic tubercle.

There are various causes for parietal lesions: adenocarcinoma appearing as short, irregular thickening; digestive metastases, particularly of melanoma, which most often affect the ileum; carcinoid tumours; inflammatory lesions related to Crohn’s disease, which is a very common cause of mechanical occlusion of the small intestine causing parietal thickening, sclerolipomatosis, a well-differentiated wall and often the appearance of fistulae or peri-intestinal abscesses; and finally, ischaemic or radiation lesions with circumferential thickening often looking like a target or double target, or a moderate peri-intestinal inflammatory lesion.

Diagnostic traps
As previously stated, the absence of a lesion identified at the transition zone is an indirect argument in favour of an adhesion band; finding a beak or fat notch sign will confirm this diagnosis.

Differentiating between a single long thin band, a thick, short, single adhesion and multiple adhesions is still difficult; it is often hard to identify transition zones in multiple adhesions because there is only a moderate difference in size between the intestine upstream and downstream.

External hernias other than inguinal or femoral hernias are easy to diagnose provided, of course, that you know what they look like, and look for them (Fig. 5).

Diagnosis of an internal hernia is still very difficult, even using CT [17,18]. The encapsulated appearance of the loops is not pathognomonic. It is difficult to be sure that the position of the digestive tube is abnormal and vascular markers need to be used to confirm the diagnosis: the right or left peri-colonic vessels anterior to para-duodenal hernias, an abnormal distance between the hepatic portal vein and the inferior vena cava in hernias through the foramen of Winslow.

Finally, while the diagnosis of intestinal intussusception is easy with CT, diagnosing its cause remains more of a problem, and it is difficult to differentiate the head of the intussusceptum from a possible tumour causing the invagination (Fig. 6).

Key elements of the report
It is important to state the cause of the mechanical occlusion of the small intestine in the report, since this has a direct impact on treatment—laparotomy, laparoscopy, or medical treatment with a nasogastric tube in a surgical environment.

Secondly, a number of causes, such as a single adhesion band and internal or external hernias, are very often associated with closed loop occlusions with a greater risk of strangulation.

Finally, it should be noted that it is important to differentiate between a single adhesion band and multiple adhesions, because a single band more often induces a risk of strangulation and can be more easily treated by laparoscopy,
Mechanical occlusions: Diagnostic traps and key points of the report

Figure 5. Mechanical obstruction of the small intestine due to a right Spiegel hernia. The axial slice (a) and sagittal reconstruction (b) show a dilated loop of small intestine passing through a hernia orifice between the right rectus muscle and the muscles of the right anterolateral wall of the abdomen. The transition between the dilated and the collapsed small intestine is clearly visible, in particular on the sagittal slice (arrow).

with a lower risk of recurrence of occlusion than when multiple adhesions are treated.

In the case of a single band, it is also useful to provide a 3D volume reconstruction, showing, before any laparoscopy, the site of the band relative to the umbilicus in the frontal and sagittal planes.

Oclusions of the colon
Colon adenocarcinomas are the prime cause of mechanical occlusion of the colon. Colorectal cancer accounted for over 80% of 234 patients included in a study who had undergone emergency surgery for colonic obstruction [19].

Extra-colonic cancers and volvulus are more rarely the cause of colonic occlusion. Hernia, diverticulitis, ischaemic colitis, colonic intussusception and tuberculosis are even rarer causes of acute colonic obstruction.

*Positive diagnosis*
As for mechanical occlusion of the small intestine, CT can detect extrinsic, parietal and intraluminal lesions.

Extrinsic causes can be volvulus, hernia and compression by diseases affecting neighbouring organs.

Intrinsic causes are tumours, diverticulitis, inflammatory diseases and ischaemic colitis.

Colocolic intussusception is the intraluminal cause.

Figure 6. Acute intestinal intussusception due to an angiomatous tumour of the small intestine. The axial slice (a) and coronal reconstruction (b) clearly show the acute intestinal intussusception, with penetration of a loop of small intestine and mesentery into another small intestine loop. However, it is difficult to distinguish the tumour responsible for the invagination of the head of the intussusception (an angioma was found on surgery).
In colon cancer, CT perfectly displays short, irregular, asymmetric thickening of the bowel wall causing narrowing of the lumen and upstream dilatation, making identification and analysis of the tumour easier.

**CT traps**
False positives for mechanical occlusion of the colon can occur in some cases of functional ileus with dilatation of the right and transverse colon and a collapsed left colon.

False positives for rectal lesions can be observed when there is no rectal distension, which is sometimes necessary by air insufflation.

False negatives for colon cancer have been described in partial obstructions, when there is no upstream distension of the colon to help visualise parietal thickening which, in some cases, is relatively moderate.

Differentiating between cancer of the colon and diverticulitis is sometimes difficult. The presence of a liquid infiltration of the root of the mesosigmoid and dilatation of mesosigmoid vessels points towards diverticulitis, whereas the presence of lymph nodes near the parietal thickening of the colon suggests cancer [20,21].

Where there is mechanical obstruction due to cancer of the colon, a second location must be sought (Fig. 7).

Diagnosis of caecal volvulus, the second most frequent form of volvulus after sigmoid volvulus, can be difficult, because its appearance is not unequivocal. The CT appearance depends on the type of volvulus [22], which can be organoaxial when the caecum remains in the right iliac fossa, mesenteroaxial when the caecum rotates into the epigastrium, left hypochondrium or left iliac fossa (Fig. 8), or limited to caecal displacement without rotation.

**Key elements of the report**
The prime cause of mechanical occlusion of the colon is colon cancer, and the treatment of a mechanical occlusion

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**Figure 7.** Mechanical occlusion of the colon due to colon cancer with a second caecal site: a, b: the axial slice (a) and coronal reconstruction (b) very easily show moderate dilatation of the left colon with irregularly contoured, short, stenosing thickening at the junction of the left colon with the sigmoid colon, corresponding to an adenocarcinoma; c, d: another site is detected on the inner wall of the caecum, both in axial (c) and coronal (d) slices.
Mechanical band submucosal of shaped in teric the larisation indicating matous reported lus, occlusions as a loop. CT seen virtually usually In This lack wall CT, the mechanisms at their occlusions of the small intestine and also in the same percentage of occlusions of the colon. It is characterised by lack of vascularisation of the occluded loops.

CT signs
The mechanisms causing strangulation of the small intestine and the CT signs which allow it to be diagnosed were initially reported by Balthazar more than twenty years ago [23]. In the first instance, a closed loop occlusion develops, indicating the same obstacle, which could be an adhesion band or a hernia, obstructing at two different points of the loop. In CT, a closed loop occlusion appears as the C, U or W-shaped distribution of one or more loops of the intestine with their mesenteric vessels converging radially.

When present, a mesenteric whirl sign can indicate volvulus, in addition. This closed loop obstruction represents a risk of strangulation with intestinal ischaemia, seen in CT as changes in the wall of the intestine plus changes in the fat and mesenteric vessels. The modifications to the intestinal wall appear either as circumferential thickening of the wall indicating submucosal oedema in the case of onset of ischaemia, or as lack of parietal enhancement with the appearance of a virtually invisible wall indicating transmural infarction. Early reversible ischaemia is often associated with oedematous infiltration of the mesentery and engorgement of the draining veins. In the case of infarction, there may be a high density serohaematic effusion between the affected loops and/or parietal pneumatosis or portomesenteric venous gas.

As regards occlusions of the large intestine, intestinal ischaemia may occur at a distance from the site of occlusion in the event of caecal distension, sometimes associated with caecal pneumatosis and representing a risk of diastatic perforation.

Diagnostic traps
The whirl sign indicating rotation of the mesentery and a volvulus with closed loop occlusion is not specific, and may be present when there is no volvulus and even when there is no occlusion in patients with a history of surgery. In a retrospective study including occlusions in a neoplastic context, most of the patients who had a volvulus of the small intestine had this whirl sign, but most of the whirl signs were not related to a volvulus [24].

Thickening of the wall of the intestine is obviously not specific for ischaemia and may be seen with infectious or inflammatory processes. In addition, when there is ischaemia, this sign is not very predictive of its reversible or irreversible character (Fig. 9).

Pneumatosis may also be the consequence of gastrointestinal distension without ischaemia (Fig. 10): in a study of occlusions of the colon of sigmoid origin with caecal pneumatosis, we showed, on surgery, that half of these cases of pneumatosis were not accompanied by caecal ischaemia [25].

While lack of enhancement of the intestinal wall is still the main sign confirming ischaemia complicating a mechanical obstruction [26], it is important, firstly, to wait for the portal phase to evaluate the intestinal wall properly, and secondly, to know how to identify a reduction in enhancement (Fig. 11). If there has been no injection of iodine, spontaneous hyperdensity of the intestinal wall, indicating haemorrhage, is a useful sign for diagnosing strangulation.

Figure 8. Caecal volvulus with the caecum in the pelvis and the left hypochondrium. The axial slice (a) and coronal reconstruction (b) clearly show the whirl sign with twisting of the mesenteric vessels, while in the sagittal reconstruction (c) a beak sign (arrow) can be clearly seen at the junction between the dilated caecum and the collapsed right colon.
Figure 9. Thickening of the wall of the small intestine upstream of a mechanical occlusion due to an adhesion band with moderate ischaemia. The beak sign is clearly visible on the coronal reconstruction (a, double arrow), whereas symmetric, circumferential wall thickening, with double target enhancement can be seen both on the axial section (b) and on the coronal reconstruction (arrow). Surgery found moderate ischaemia of an upstream loop of the small intestine which was easily reversible by warming.

Figure 10. Mechanical occlusion of the small intestine with pneumatosis but no intestinal ischaemia: a: the coronal reconstruction clearly shows dilatation of the loops of the small intestine; b, c: axial slices through the liver (b) and mesentery (c) with wide window show characteristic portal gas and intestinal parietal pneumatosis, because air bubbles occur anterior to the air-fluid level within the loops of the small intestine (c). Surgery found no signs of intestinal damage.
Figure 11. Mechanical occlusion of the small intestine due to an adhesion band in a pregnant woman: a: the coronal reconstruction clearly shows the beak sign downstream of a small bowel faeces sign; b: on the axial slice, there is reduced enhancement of an ileal wall (arrow). Surgery confirmed the strangulation mechanism, which required resection of 20 cm of the small intestine.

Key elements of the report
Strangulation is an essential item of the report, particularly as a non-surgical approach is recommended as first-line treatment if it is absent; however, this will induce morbidity and mortality if strangulation passes unnoticed.

The performance of CT in the diagnosis of strangulation is variously appreciated in the literature and would require a meta-analysis to evaluate it. The most reliable sign is the absence of enhancement of the wall of the intestine, so that in a CT report it is essential therefore to describe the presence or absence of signs of strangulation, noting normal or abnormal enhancement of the intestinal wall.

Therapeutic impact
There has been a change in paradigm over the last twenty years in the management of mechanical occlusions of the small intestine due to adhesion bands. The attitude of never letting the sun rise or set on a mechanical occlusion of the small intestine has been replaced by the current strategy of a more wait-and-see attitude in certain conditions.

When there are clinical and/or CT signs of strangulation, the patient must undergo emergency surgery. Of these CT signs, the best parameter of intestinal ischaemia requiring resection is lack of enhancement of the intestinal wall [27]. Other parameters, such as an abundant peritoneal effusion, a whirl sign and the absence of the small bowel faeces sign seem, especially for one team [28,29], to be predictive parameters requiring surgical resection.

In the absence of clinical and CT signs supporting strangulation, the current recommendations produced during consensus meetings [30,31] are medical treatment, with a nasogastric or jejunal probe associated with re-establishing water and electrolyte balance and diet. If the occlusion is not resolved with this treatment within 2 to 3 days, surgical treatment is recommended. This can be laparoscopic, particularly if it is the first case of mechanical occlusion of the small intestine and a single adhesion band is suspected rather than multiple adhesions. However, 30% of patients treated with a non-operative approach do not respond to it and have to undergo surgery. Two studies [10,11] have focused on the contribution of CT as a predictive factor of this need for later surgery, with relatively consistent results and highlighting one main sign – the occlusion being high-grade.

TAKE-HOME MESSAGES
- CT is the principal imaging examination for the positive diagnosis and assessment of a mechanical occlusion of the small intestine.
- Positive diagnosis is based on identifying a dilatation of the intestine and a transition zone between the small bowel and the collapsed intestine.
- The small bowel faeces sign is a useful indicator of the site of occlusion. However, its value as a sign of severity and for predicting spontaneous resolution of mechanical occlusion without surgical treatment is very much open to discussion.
- Diagnosis of the degree of occlusion is rarely included in CT reports. This is wrong, because it is a pointer for the efficacy of medical treatment and the need for surgery in occlusions due to adhesive bands with no clinical or CT signs of severity.
- The main cause of mechanical occlusion is an adhesive band, which has positive signs: the beak and fat notch sign.
- The main cause of mechanical occlusion of the colon is colon cancer. It is important, while performing the CT scan, not to forget staging, especially local staging (lymph nodes), or to search for another tumour site in the colon.
- The gastroduodenal region is a much rarer site for occlusion; the chief causes are antpyloric
adenocarcinoma, stenosis following peptic ulceration and gastric volvulus.

- In examination of mechanical occlusion of the small intestine, it is important to understand the mechanism using CT imagery: one or more transition zones, entrapment with two transition zones very close together etc. It is also important to look for the signs of severity: lack of enhancement of the wall of the intestine, localised infiltration of the mesentery.

- With an ischaemic occlusive condition, apart from the total lack of enhancement of the intestinal wall or perforation, it is very difficult in CT to differentiate the loops that will be viable after warming procedures from loops that require intestinal resection.

Clinical case

This 35-year-old male patient, with a history of Sturge-Weber syndrome, presented with symptoms of mechanical occlusion. A CT scan was performed: a coronal slice (Fig. 12a) and three axial slices (Fig. 12b–d) are presented here.

Questions

1. Describe the abnormalities.
2. What is your diagnosis?
   - Acute intestinal intussusception?
   - Biliary ileus?
   - Occlusion due to adhesion bands with a small bowel faeces sign?
   - Bezoar?
   - Tumour of the small intestine?
3. Explain your diagnosis.

Answers

1. Description of the abnormalities: the axial slice and narrow window coronal reconstruction (Fig. 12a, b) show dilatation of the loops of the small intestine, indicating a mechanical obstruction with an oblong ileal formation extending for 8 cm, with mixed liquid and gas content. The wider window axial slices (Fig. 12c, d) clearly show that this formation is well defined and contains some air

Figure 12. Abdominal CT scan: a: coronal reconstruction; b–d: axial slices.
bubbles but also linear components of fat density. This is thus the appearance of a bezoar.

2. Diagnosis: bezoar.

3. Reasons for the diagnosis: generally, in CT, the distinction between a bezoar and a small bowel feces sign is based on precise features: a mass in clumps with mixed content and well-defined contours, extending over a short length, usually less than 10 cm, sometimes associated with the same type of formation in the stomach (not found in this patient), with fatty debris within the mass or upstream.

The evidence supporting a bezoar comprises the following: very clear contours, the material of fat density, the short length, and the existence of the same type of lesion in the stomach.

In this patient, Sturge-Weber syndrome was the cause of mental retardation, explaining the ingestion of a foreign body.

There are several types of bezoar:

- phytobezoars resulting from an accumulation of fibrous vegetable substances;
- trichobezoars consisting of an accumulation of hair;
- other bezoars consisting of various ingested substances: medicinal products with a particular coating for prolonged release, cotton, sponge, etc.

Surgery with a short midline laparotomy confirmed occlusion of the terminal ileum in this patient due to a foreign body (sponge). It was treated by a 1 cm enterotomy.

**Disclosure of interest**

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

**References**
