



ICONOGRAPHIC REVIEW / *Gastrointestinal imaging*

Closed loop obstruction: Pictorial essay

A. Mbengue^{a,*}, A. Ndiaye^a, T.O. Soko^a, M. Sahnoun^a,
A. Fall^a, C.T. Diouf^a, D. Régent^b, I.C. Diakhaté^a

^a Département d'imagerie médicale, hôpital Principal, 1, avenue Nelson-Mandela, BP 3006, Dakar, Senegal

^b Service de radiologie, CHRU de Nancy-Brabois, rue du Morvan, 54511 Vandœuvre-lès-Nancy, France

KEYWORDS

Closed loop obstruction;
Incarceration;
Volvulus

Abstract Closed loop obstruction occurs when a segment of bowel is incarcerated at two contiguous points. The diagnosis is based on multiple transitional zones. The incarcerated loops appear in U or C form or present a radial layout around the location of the obstruction. It's very important to specify the type of obstruction because, in patients with simple bowel obstruction, a conservative approach is often advised. On the other hand, a closed loop obstruction immediately requires a surgical approach because of its high morbidity and the risk of death in case of a late diagnosis.

© 2013 Éditions françaises de radiologie. Published by Elsevier Masson SAS. All rights reserved.

An obstruction is said to be closed loop or incarceration when a bowel segment of variable length is obstructed at two contiguous points. The incarcerated and distended loop risks, if long enough, pivoting on its axis and resulting in a volvulus [1].

Why should a closed loop obstruction be recognized?

In the small intestine, mechanical obstruction caused by adhesions presents a lower risk of complications and therefore, a more conservative approach by suction and hydroelectrolytic restoration may be considered. However, closed loop obstructions are characterized by their complete nature and high morbidity and risk of death in case of delayed surgery [2].

In the colon, ischemic complications only occur on volvulus. The most important factor in the prognosis is the time before care. Simple mechanical colon obstructions more often present a risk of diastatic perforation.

* Corresponding author.

E-mail address: mbenguerx@yahoo.fr (A. Mbengue).

Physiopathological basis

There are two types of obstructions (Fig. 1):

- simple mechanical obstruction: a bowel segment is obstructed at one point;
- closed loop obstruction or incarceration: a loop of variable length is obstructed at, at least, two adjacent points [2,3].

In the small bowel, closed loop obstructions may be secondary to obstruction caused by adhesions, a volvulus, or an internal or external hernia. In the colon, in most cases, it consists of sigmoid volvulus.

The consequences of intestinal tract obstruction differ according to whether it involves a simple obstruction or incarceration.

In simple mechanical obstruction

The supralesional effect is fast and first involves hyperperistalsis. The accumulation of gas upstream from the obstacle is the initial cause of intestinal distension within three to six hours. This gas distension is then increased by retention of fluids after 12 hours, resulting from the absorption and exaggerated intestinal secretion.

In close loop obstruction

Two obstructive features combine and are responsible.

Closed loop syndrome

The incarcerated loop (closed loop) continues secreting and will very quickly distend, inducing parietal vascular constraints. It does not contain gas, or contains very little gas, except when it involves the colon (fermentation gases).

The venous stasis induces the extravasation of blood and plasma both in the excluded loop and in the adjacent mesentery, increasing the intestinal distension.

A supralesional syndrome

The segment of intestine upstream from the proximal point of obstruction progressively distends to the stomach. This distension is slower than in case of a incarcerated segment. Two situations are possible:

- the upstream segment distends provoking tympanites and vomiting;
- in some cases, the evolution is so fast that the supralesional segment doesn't have enough time to dilate. Only the incarcerated loop is distended. These so-called "flat belly" obstructions evolve on the ischemic side, quickly

resulting in strangulation with intestinal necrosis. Clinically, the picture is dominated by intense abdominal pain sometimes associated with peritoneal signs. There is no vomiting or tympanites (the supralesional segment of intestine is flat).

Strangulation is the main risk of mechanical obstruction and the mortality rate is high [1]. It is almost always secondary to a closed loop obstruction with adhesions or hernia. The adhesions are above all responsible for agglutination of loops with incomplete obstruction [4]. Three factors contribute to the installation of strangulation:

- the compression of the vascular pedicle of the loop at the level of obstruction;
- the distension of the obstructed closed loop;
- the torsion of the intestinal loop upstream, its feeder vessels and its mesentery in case of associated volvulus.

When installed, the arterial ischemia quickly leads to gangrene and then perforation with generalized peritonitis. In experimental animal models, a complete vascular obstruction leads to a loss of villi within 1 hour and parietal infarction after 8 hours [5].

CAT-scan diagnosis

Closed loop obstructions without volvulus of the incarcerated loop where the signs of lesion are mainly on the latter should be distinguished from obstructions with volvulus where the signs of volvulus are in the forefront and possibly associated with signs of incarceration.

The CAT-scan is currently the best imaging tool for the pre-surgical assessment of high grade mechanical obstructions with a sensitivity of 90 to 96%, a specificity of 96% and a diagnostic precision of 95% [6]. With its performance in the detection of strangulation, it is the best way to select patients who may benefit from primary medical care.

Semiological basis of closed loop obstruction

In cases of simple obstruction, the signs include a single zone of transition separating a distended proximal segment from a flat downstream segment.

The semiology differs in closed loop obstruction and is related to the presence of 2 zones of proximal and distal obstruction. The site of obstruction presents in the form of several contiguous zones of transition, often with a "beak-like" appearance. The number of transition points (2 or 3) depends on presence or not of distension of the upstream segment (Fig. 2). The proximal level of obstruction is characterized by a double dilation on both sides and the zone of

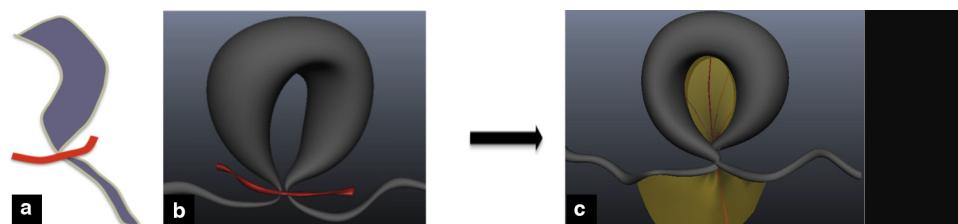


Figure 1. Illustration of a simple obstruction (a), a closed loop obstruction (b) and a closed loop obstruction with volvulus (c).

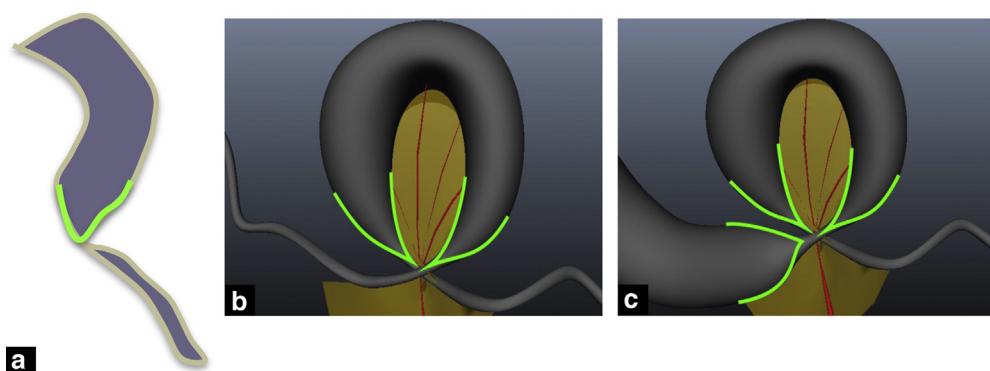


Figure 2. Illustration of the number of transitional zones according to the type of obstruction; a: simple obstruction: 1 beak-shaped zone of transition; b: incarceration without distension upstream (flat belly obstruction): 2 zones of transition; c: incarceration with distension upstream: 3 zones of transition.

transition. It is therefore necessary to carefully look for the distal place of obstruction that complies with the classic semiology of distended loop—transitional zone—flat downstream loop (Fig. 3) [3]. The presence of several “contiguous beaks” is very specific for incarceration.

The incarcerated intestinal segment presents liquid distension with a configuration depending on the degree of distension, the length and orientation of the loops in the abdomen:

- a “U” or “C” shaped layout, if the incarcerated segment is almost entirely visible in the same plane. Using multi-plane reformations is very helpful in detecting this layout of the loops (Fig. 4);
- a radial layout of the loops and mesenteric vessels converging towards the place of torsion if the incarcerated segment is very long. (Figs. 5 and 6) [1,2].

Specific case of “flat belly” obstructions

In “flat belly” obstruction, the CT detects a liquid distension of a group of loops corresponding to the incarcerated segment. The proximal loops and the stomach are flat. For an uninformed observer, the lack of suprarectal dilation (proximal loops) may lead to a diagnostic error. It is

necessary to carefully analyze the wall of the distended loop segments that are very often the seat of suffering (Fig. 7).

Close loop obstruction with volvulus.

Volvulus may complicate a closed loop obstruction when the incarcerated segment is long enough. It may also be the primary mechanism when a loop topples over from an adhesion inserted at its top, in volvulus of the small intestine on incomplete joint mesentery or volvulus of the sigmoid. It forms the most serious vascular obstruction.

In the small intestine, it most often complicates incarceration on adhesions. In the CT, signs of closed loop obstruction are associated with a “whirl sign” [2]. The “whirl sign” corresponds to the winding of the mesenteric vessels and mesos that converge towards the mesenteric point of torsion. The association of multiple transition zones (specific with incarceration) and whirl sign is highly indicative of a volvulus with a 100% specificity reported in the literature [7]. It is necessary to remember that a “whirl sign” may be found in normal subjects and therefore is only significant in a context of mechanical obstruction [8].

In the colon, the volvulus is generally spontaneous by rotation of a long sigmoid loop. On both types of sigmoid

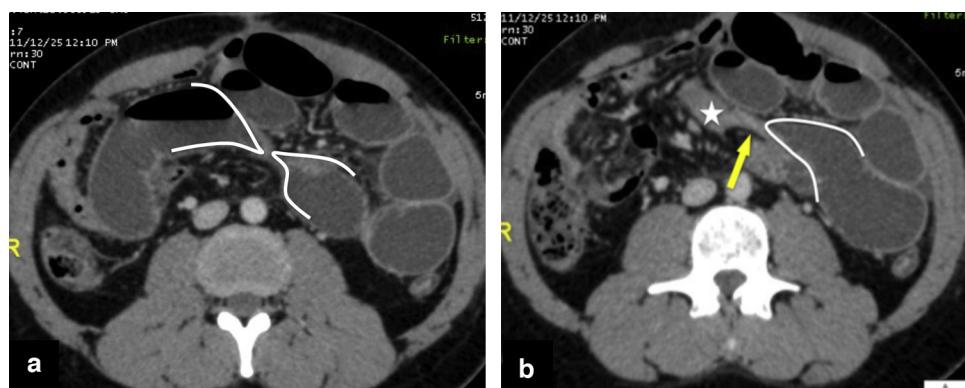


Figure 3. Closed loop obstruction of the small intestine: 3 “beak sign”; a: proximal point of obstruction: double dilation on both sides of the transitional zone (arrow); b: distal point of obstruction: small intestine dilated upstream—zone of transition (arrow)—small intestine flat upstream (star).



Figure 4. Frontal CT image of 2 different patients. Obstruction by incarceration with layout in C (a) and U (b) of the incarcerated loop.

volvulus described, only one of them forms a closed loop [9] ([Fig. 8](#)):

- the organo-axial volvulus (recently individualized) does not correspond to a closed loop because the torsion arises following to the longitudinal axis on only one site of the sigmoid. In the CT, there is distension of a dolicho-sigmoid without pelvic convergence of the distended segments ([Fig. 9](#));
- the mesenterico-axial volvulus forms a closed loop obstruction by rotation of the sigmoid loop around its

meso with convergence of 2 descenders towards the torsion point ([Fig. 10](#)).

Strangulation – ischemia

The clinical diagnosis of strangulation remains difficult and the CT is the best imaging examination to confirm, with a sensitivity of 80 to 100% and a specificity ranging from 61 to 93% [[10,11](#)].

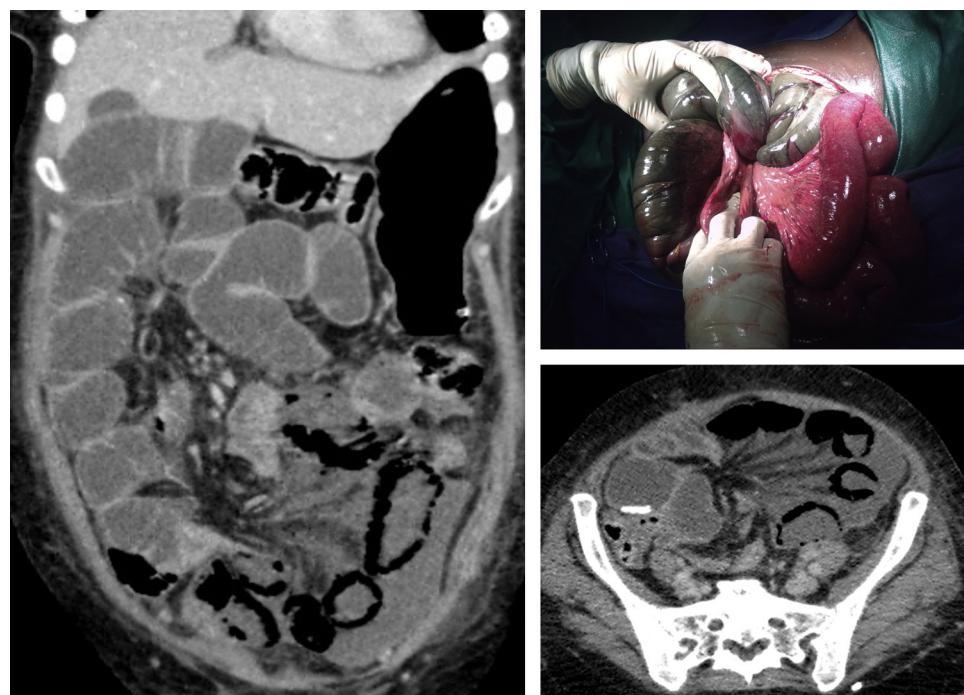


Figure 5. Obstruction by incarceration complicated by intestinal necrosis in a 65-year-old diabetic. Coronal (a) and axial view (b) after injection: radial layout of the dilated loops converging towards the place of obstruction associated with parietal pneumatosis. Transmural necrosis confirmed by surgery (c).

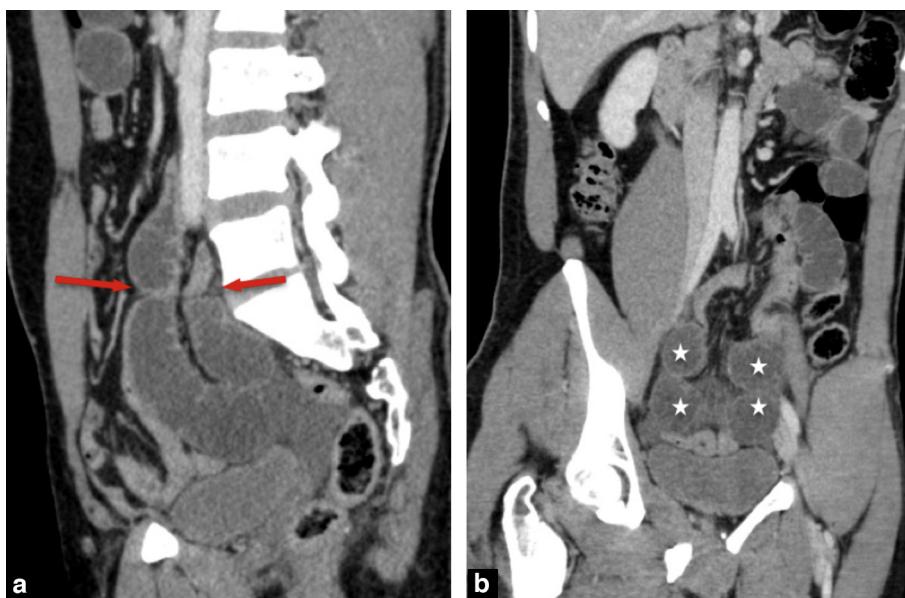


Figure 6. Frontal CT image of a mechanical closed loop obstruction of the small intestine. Contiguous zones of transition (right arrow) with double dilation on both sides of the place of proximal obstruction (a). Radial layout of incarcerated loops towards the place of obstruction (asterix) (b).

Usually, the CT signs of the severity of a mechanical obstruction of the small intestine are the same as in close loop obstruction in addition with specific sign of strangulation.

Two stages of strangulation may be differentiated [12]:
• low grade, often reversible strangulation resulting from essentially venous vascular compression. It appears as in parietal thickening with target enhancement (attesting to a sub-mucous oedema), mesenteric

venous engorgement and sometimes peritoneal effusion (Fig. 11);

- ischemia with transmural infarction, resulting from tight arterial constriction (Fig. 12). It combines variably, spontaneous hyperdensity of the intestinal lining, infiltration of the meso, a lack of enhancement after injection (Figs. 7 and 13), sero-haematic inter-loop effusion and an ultimate stage of parietal pneumatosis (Fig. 5) with portal and mesenteric venous gas [10,11].

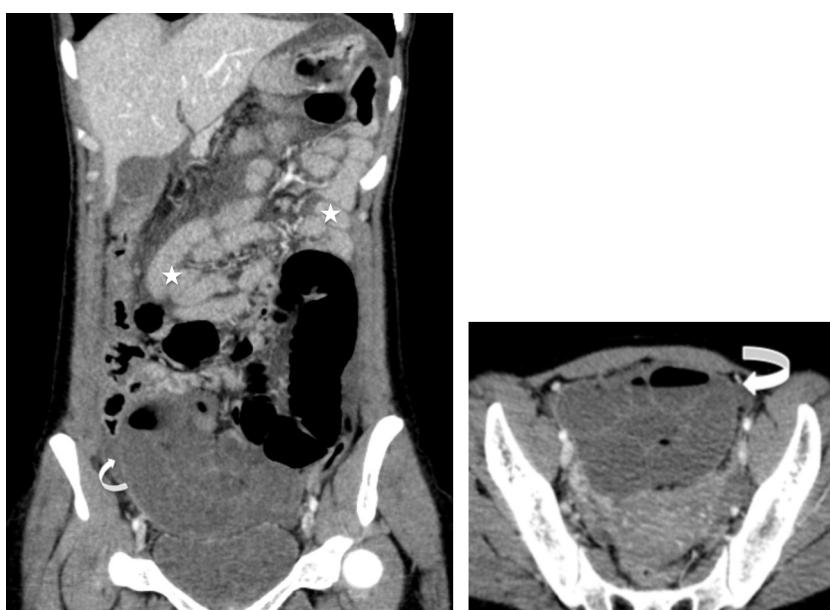


Figure 7. Flat belly obstruction: coronal (a) and axial CT image (b). Incarcerated loop distended in C (curved arrow). No distension upstream; flat jejunal loops (stars) (a). Lack of enhancement of the incarcerated loop and ascites attesting to intestinal necrosis (a, b).

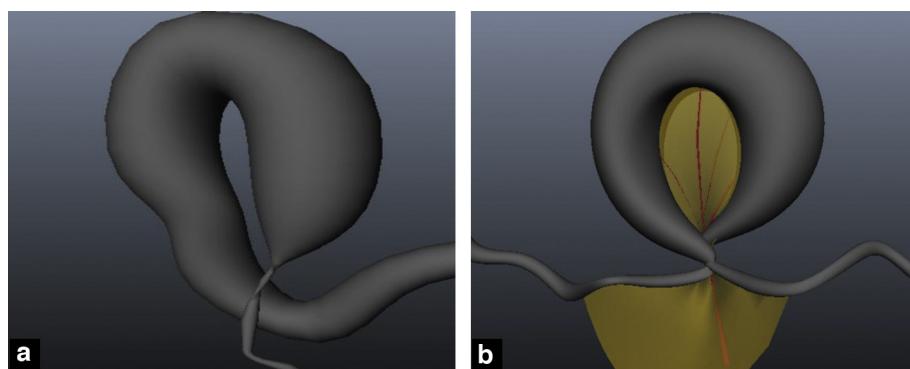


Figure 8. Illustration of 2 forms of volvulus of the sigmoid; a: organo-axial volvulus; b: mesenterico-axial volvulus.



Figure 9. Organo-axial volvulus of the sigmoid. Colic gas distension without "coffee bean image" on the abdominal pain film (a). Coronal CT image (b): torsion of the sigmoid around its longitudinal axis.

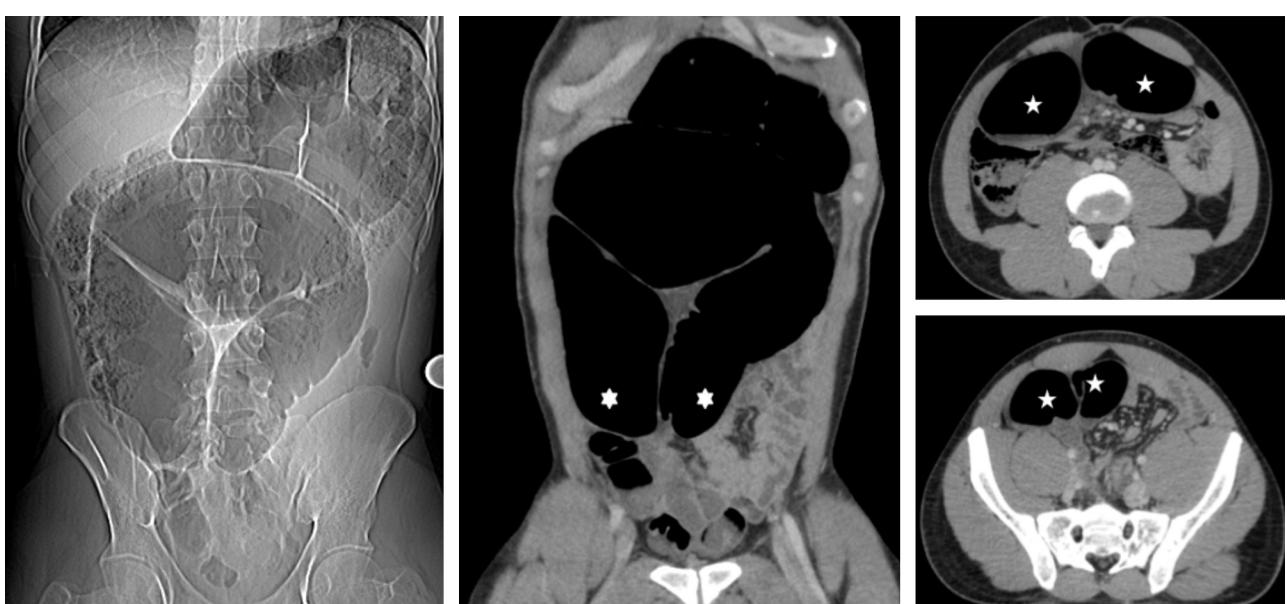


Figure 10. Mesenterico-axial volvulus of the sigmoid. "Coffee bean" image abdominal pain film (a). Coronal (b) and axial CT image (c, d): convergence of 2 sigmoid descenders (asterix) towards the place of torsion.



Figure 11. Front (a) and axial (b and c) CT images after injection of an obstruction by incarceration. Note the mesenteric venous engorgement near the zone of obstruction associated with pelvic peritoneal effusion. No sign of intestinal distress during surgery.



Figure 12. Closed loop obstruction with intestinal ischemia. Lack of enhancement of the incarcerated loop (curved arrow) with "feces sign".

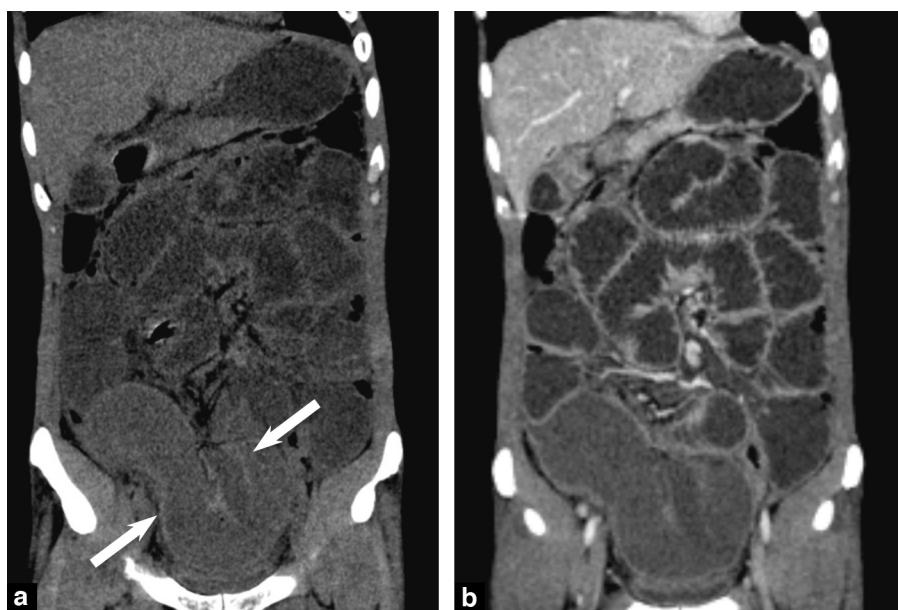


Figure 13. Coronal CT image without (a) and with injection (b) of a closed loop obstruction on adhesions with intestinal ischemia. Spontaneous hyperdensity of the walls of the incarcerated loops (arrow in a) and lack of enhancement after injection (b). Note the hyperdense sero-hematic contents of the ischemic loop (a).

Conclusion

Closed loop obstructions or obstructions by incarceration should immediately be considered as serious mechanical obstructions. Their diagnosis by CT-scan is based on the detection of multiple adjacent zones of transition with either a radial layout or a layout in C or U of the incarcerated loops towards the place of obstruction. Any delay in the diagnosis is harmful due to the high risk of intestinal necrosis. It is imperative to differentiate them from a simple obstruction that may benefit from conservative approach.

Disclosure of interest

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

References

- [1] Deneuville M, Beot S, Chapuis F, Bazin C, Boccaccini H, Regent D. Imagerie des occlusions intestinales aiguës de l'adulte. EMC 1997;33–710–A–10 [Radiodiagnostic IV – Appareil digestif].
- [2] Balthazar EJ. CT of Small-Bowel Obstruction. AJR 1994;162:255–61.
- [3] Silva AC, Pimenta M, Guimaraes LS. Small bowel obstruction: what to look. RadioGraphics 2009;29:423–39.
- [4] Delabrousse E, et al. Small-bowel obstruction from adhesive bands and matted adhesions: CT differentiation. AJR 2009;192(3):693–7.
- [5] Will JS. Closed-loop and strangulating obstruction of the small intestine: a new twist. Radiology 1992;185:635–6.
- [6] Silva AC, Pimenta M, Guimaraes LS. Small bowel obstruction: what to look for. RadioGraphics 2009;29:423–39.
- [7] Sandhu PS, Joe BBN, Coakley PDF, et al. Bowel obstruction points: multiplicity and posterior location at CT are associated with small bowel volvulus. Radiology 2007; 245:1.
- [8] Gollub MJ, Yoon S, Smith LM, Moskowitz CS. Does the CT whirl sign really predict small bowel volvulus? Experience in an oncologic population. J Comput Assist Tomogr 2006;30: 25–32.
- [9] Bernard C, Lubrano JB, Moulin V, Kastler B, Mantion G, Delabrousse E. Apport du scanner multi-detecteurs dans la prise en charge des volvulus du sigmoïde. J Radiol 2010;91:213–20.
- [10] Balthazar EJ, Liebeskind ME, Macari M. Intestinal ischemia in patients in whom small bowel obstruction is suspected: evaluation of accuracy, limitations, and clinical implications of CT in diagnosis. Radiology 1997;205:519–22.
- [11] Sheedy SP, Earnest IVF, Fletcher JG, Fidler JL, Hoskin TL. CT of small bowel ischemia associated with obstruction in emergency department patients: diagnostic performance evaluation. Radiology 2006;241:729–36.
- [12] Delabrousse E. Syndromes occlusifs du grêle et du colon. In: Vilgrain V, Regent D, editors. Imagerie de l'abdomen. Paris: Médecine Science Lavoisier; 2010. p. 941–2.