Volvulus characterization in radiology: A review

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Learning objectives

- To describe the main imaging findings of volvulus - stomach, cecal, sigmoid and small bowel - in conventional radiology, fluoroscopy and computed tomography (CT).

- To demonstrate their contribution to make the diagnosis and to evaluate severity.

Background

Introduction:

Volvulus is a visceral twisting around its proper or mesenteric axis, constituting a relative uncommon cause of intestinal occlusion (IO) or sub-occlusion, which may be acute or chronic in presentation. Its name depends of the involved viscera and thus we can distinguish between gastric, small intestinal and colonic volvulus.

Imaging tests, essentially conventional radiography, fluoroscopy and CT are useful for surgeons to discover the IO aetiology and to better guide the therapy.

A) Epidemiology and pathophysiologic mechanism

Gastric volvulus

- Uncommon and usually acquired
- In adults, above 50 years old

- **Aetiology**
  - Primary - weakness of the suspensory ligaments of the stomach
  - Secondary - paraesophageal hernia across congenital (child) or acquired diaphragmatic defect (adults)
  - Idiopathic

- **Predisposing factors**
  - Adhesions
  - Increase of the abdominal pressure conditioning increase of the hiatal hernia volume.

- **Pathophysiologic mechanism**

o Three types

Organoaxial: stomach twists around its long axis, frequently resulting from a secondary etiology.

Mesenteroaxial: stomach twists around its short axis (perpendicular to the long axis), usually resulting from primary etiology

Complex: both organoaxial and mesenteroaxial components

Some authors classify volvulus depending on the clinical presentation:

Acute: obstructive/complete volvulus (>180º)

Chronic: non-obstructive/ partial volvulus or organoaxial position (<180º)

Sigmoid volvulus

- It's the most common colonic volvulus (60-75%)
- Represents the 3th most common cause of colonic IO (8%) in developed countries and pregnancy
- Affects old people (60-70 years)

- **Aetiology / Predisposing factors**
  - Acquired redundancy of sigmoid (diet rich in fibers) associated with a narrow mesenteric attachment to the posterior abdominal wall
  - Chronic constipation and laxative abuse
  - Pregnancy
  - Hospitalization
  - Chagas´ disease

- **Pathophysiologic mechanism**
  - Twist occurs around its mesentery

Cecal volvulus

- 2nd most common colonic volvulus (25-40%)
- Responsible for 2-3% of IO

- Affects old people (70 years old)

- **Aetiology / Predisposing factors**
  - A congenital defect in right colon fixation to posterior abdominal wall allows a bigger mobility of this segment of the colon. The twist begins when there is a restriction in its mobility at a fixed point, caused by adhesions or an abdominal mass.
  - Distension of the right colon (iatrogenic cause or pregnancy)

- **Pathophysiologic mechanism**
  - Torsion occurs around its mesentery and terminal ileum is usually involved too.
  - Two types:

- In 50% of cases, the cecum twists in the axial plane, rotating around its long axis. Consequently, cecum appears in the right lower quadrant of the abdomen
- In the remaining 50% of the cases, the cecum twists and inverts. In this case, cecum locates in the left upper quadrant of the abdomen.

<u>Midgut volvulus</u>

- It's an uncommon cause of IO (<1%).
- More frequent in newborn than in adults

- **Aetiology / Predisposing factors**
  - In newborns, it is frequently associated with malrotation in which there is an abnormally short mesenteric root, predisposing to twisting.
  - In adults, it is generally a complication of transmesenteric hernias, which predisposes to midgut twists into the hernial pouch.

- **Pathophysiologic mechanism**
  - Twisting occurs around its mesentery

B) Clinical findings

<u>Gastric volvulus</u>

- Partial/chronic volvulus:

- Non-symptomatic or only with unspecific abdominal symptoms

- Complete/acute volvulus:
  - Borchardt triad: sudden epigastric pain, intractable retching and inability to pass the nasogastric tube into the stomach

Colonic and midgut volvulus

- Symptoms of IO or sub-occlusion (abdominal pain, nausea, vomiting and constipation)
- Respiratory and cardiac symptoms, due to increase of abdominal volume
- Examination may reveal palpable abdominal mass, tympanic and distended abdomen

C) Complications

Because of unspecific clinical findings, diagnosis is very difficult. When volvulus persists in time, this progresses to bowel ischemia, infarction and perforation.

Imaging findings OR Procedure details

D) Imaging findings

Gastric volvulus

Conventional radiography (Fig.1 and 2)

Dilated stomach (filled with air or fluid) and collapsed adjacent bowel loops.

Elevation of left hemidiaphram

Retrocardiac air-fluid level or double air-fluid level, corresponding to paraesophageal hernia

Gastric emphysema (parietal ischemia): a radiolucent line in gastric wall.

Fluoroscopy (upper gastrointestinal (GI) series):

It is the best imaging modality for diagnosis of chronic volvulus and distinction of the various subtypes.

Displays topographic alterations of stomach (intra-thoracic component in paraesophageal hernia)

Classifies volvulus in obstructive vs non-obstructive, depending on contrast progression to the duodenum

Organoaxial(fig.3 and 4):

- Greater curvature displaced superiorly
- Lesser curvature appears inferiorly to the greater one
- Antrum rotates anterosuperiorly
- Fundus rotates posteroinferiorly

Mesenteroaxial

- Antrum displaced above the gastroesophageal junction

Obstructive

- Lack of passage of the oral contrast into the duodenum

Non-obstrutive

- Oral contrast passes into the duodenum (fig.3 and 4)

CT

Confirms rotation of the herniated stomach (fig.5)

Shows the transition point: intragastric linear septa

Useful before surgery because characterizes the diaphragmatic defects (size and location) and contents of the herniated pouch (fat, stomach and/or transverse colon)(fig.5)

Reformation in coronal plane is more helpful.

Sigmoid volvulus

Conventional radiography (fig.6)

80% of cases are detected in plain abdominal radiograms:

Distended air- filled sigmoid loop:

Inverted U-shaped or coffee-bean appearance (coffee-bean sign)
Arises from the pelvis and extends cranially
Can occupy the entire abdomen
Apex appears in paramedian position (++left upper quadrant) and above T10, with elevation of homolateral hemidiaphragm

Northern exposure sign: apex of the sigmoid loop goes beyond and remains above the transverse colon.

"Three lines" or "white stripe" sign: corresponds to the obliquely oriented vertical white lines; the central line represents the opposed walls of the dilated sigmoid loop and the two others the outer walls of this loop.

Loss of haustra

Two air-fluid levels, one in each distended loop segment (closed-loop occlusion)

Proximal colon and small bowel loops are usually air-filled, distended and the rectum is empty.

Fluoroscopy (enema study):

"Bird's beak" sign: corresponds to the level of the distal twist (recto-sigmoid junction) where the lumen appears filiform and contrast does not progress beyond this point.

CT (fig.7 and 8)

Abnormal site of the sigmoid loop

"Whirl" sign: it is composed of spiraled loops of collapsed sigmoid, low-attenuating fatty tissue and enhancing engorged vessels concerning its mesentery. Soft tissue center corresponds to source of volvulus.

Detects complications of volvulus, namely parietal ischemia and infarction:

- Wall thickening of sigmoid loop
- High attenuation or gas in its wall(haemorrhage and wall pneumatosis, respectively)
- Gas in mesenteric veins
- Mesenteric congestion
- Peritoneal fluid/air

Cecal volvulus

Conventional radiography (fig.9)

Most cases are detected in plain abdominal radiographs:

Distended cecal loop:

Air-filled or with only an air-fluid level

Positioned in the upper left quadrant

Reniform cecum: when terminal ileon is involved, the ileocecal valve appears in a medial position, creating an indentation in the medial aspect of the cecal volvulus.

Preservation of haustra

Proximal small bowel loops are usually air-filled and distended and distal colon is collapsed.

Fluoroscopy (enema study):

"Bird's beak" sign

CT(abdomen) (fig.10)

Abnormal position of the cecal loop (upper mid and left abdomen)

Distension of proximal bowel loops

"Whirl" sign

Detects complications (=sigmoid volvulus)

Midgut volvulus

Conventional radiography and fluoroscopy are not helpful in making the diagnosis in adults. In newborns, fluoroscopy sometimes reveals a typical sign, the "corkscrew-like appearance" beyond signs of malrotation of the small bowel.

CT:

- Small bowel loops are:

distended

clustered

shifted to the periphery: appear adjacent to the abdominal wall and externally to the colon.

- Proximal bowel loops are dilated.
- Colonic loops may be dislocated to the center, medially to the small bowel loops

- Mesenteric vessels are:

engorged

crowded

stretched

There is an abnormal positional relationship between the superior mesenteric artery and vein, the last one being located to the left of the artery.

- "Whirl" sign: swirling of vessels in the mesenteric root (fig.11)

- Complication of volvulus - ischemia/infarction (=colonic volvulus) (fig.11)

Images for this section:

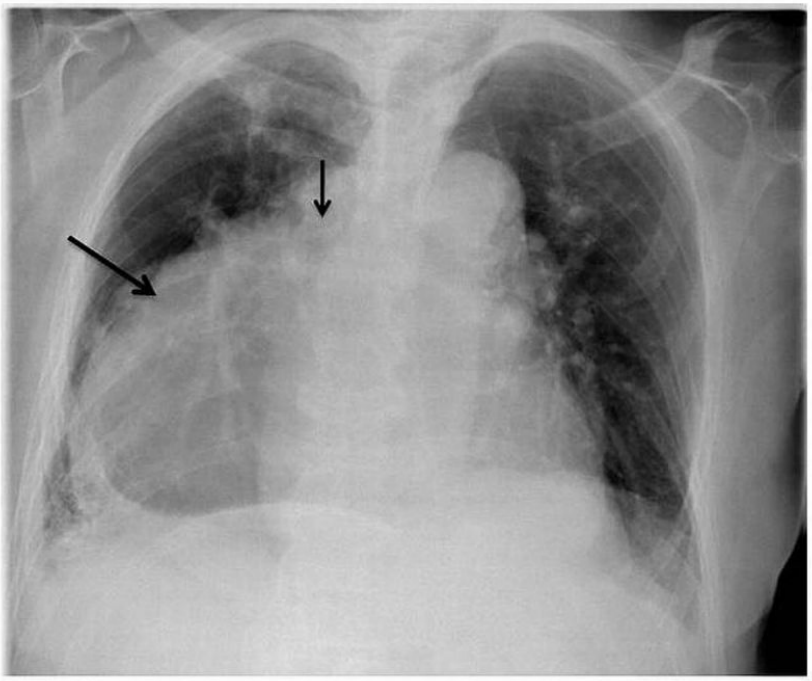

Fig.1: Organoaxial volvulus in paraesophageal hernia. This PA chest radiogram shows herniation of almost all stomach into the chest, projected over the cardiac shadow and right hemithorax (arrow). Stomach is dilated and air-filled, exhibiting its greater curvature (small arrow) in superior position.

Fig. 1

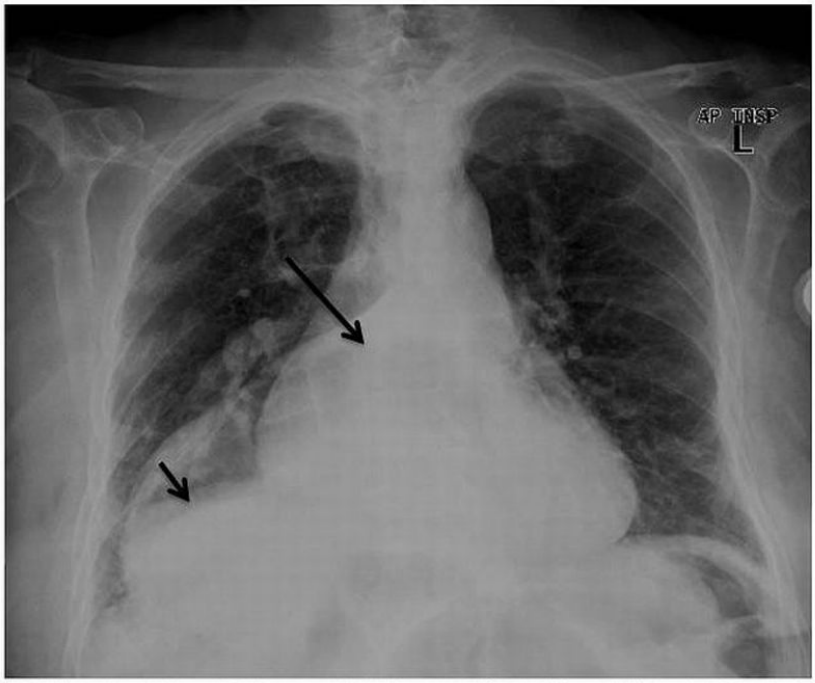

Fig.2: In the same patient, another PA chest radiogram demonstrated also intra-thoracic air-fluid level (small arrow) and images of air density projected on the cardiac shadow too, suggesting concomitant herniation of intestinal loop (large arrow).

Fig. 2

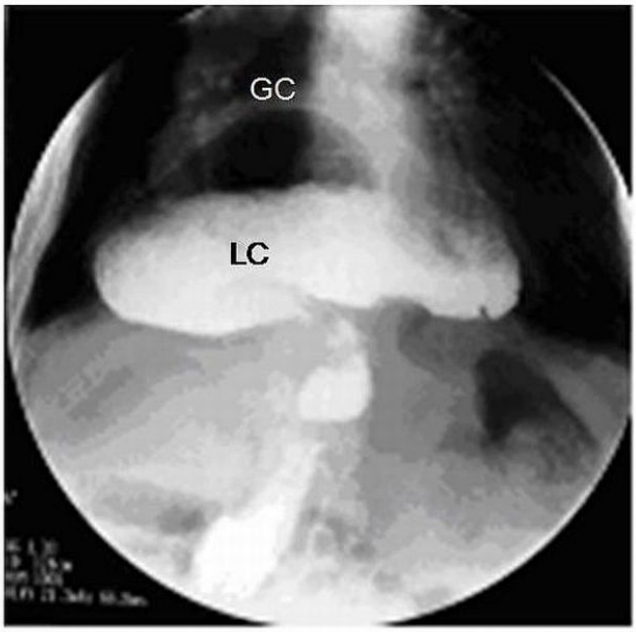

Fig.3: Organoaxial gastric volvulus: This upper GI series disclosed a large hiatal hernia. The greater curvature (GC) of stomach appears above the lesser one (LC). The contrast passed into the duodenum, indicating a non-oclusive/chronic volvulus.

Fig. 3

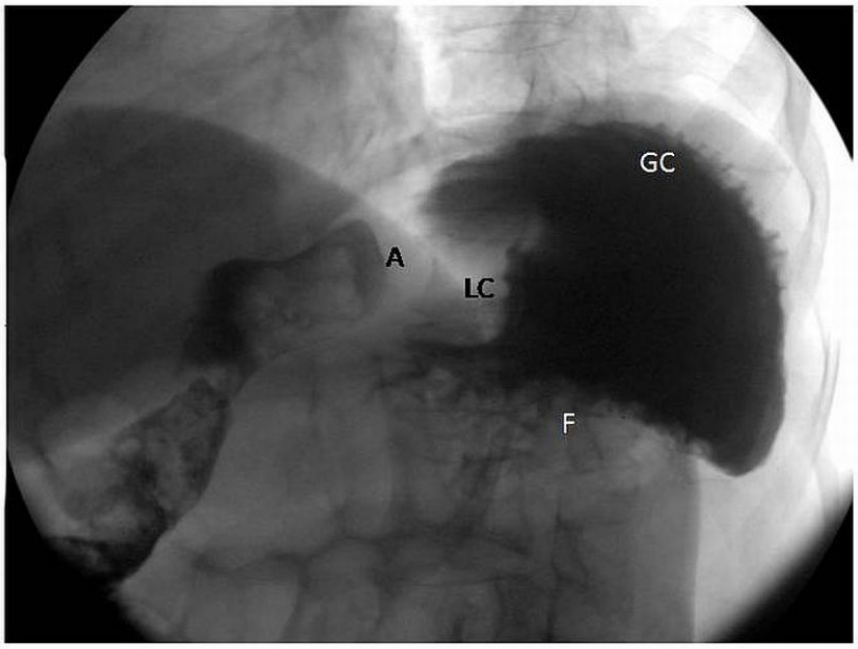

Fig.4: Organoaxial volvulus. This upper GI series (left profile) disclosed relative spatial alteration of the different parts of the stomach, located in abdomen: greater curvature (GC) superiorly to lesser(LC) one, antrum (A) rotates anterosuperiorly and fundus (F) posteroinferiorly . Progression of contrast into the duodenum reveals that it is a non-obstrutive volvulus.

Fig. 4

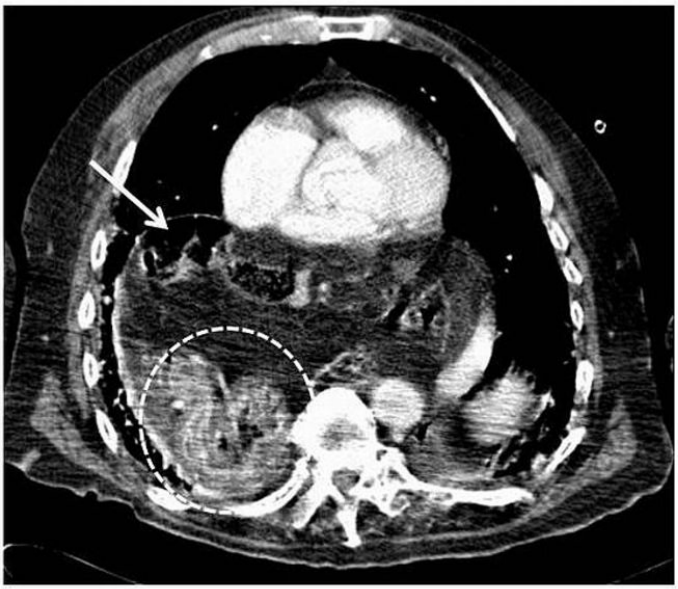

Fig.5: Organoaxial volvlus: this axial plane of abdominal CT (soft tissue window), after contrast, shows a huge hiatal hernia (white circle indicating the stomach) associated to herniation of transverse colon (arrow). There are not signs of ischemia.

Fig. 5

Fig.6: Sigmoid volvulus: this AP abdominal radiogram disclosed dilatation of sigmoid loop, with coffee-bean and three-line signs. There are two air-fluid levels and loss of haustra. Elevation of left diaphragm.

Fig. 6

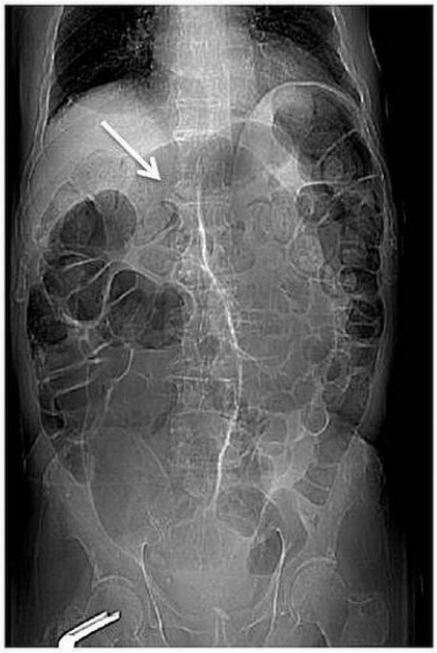

Fig.7: Scout image of abdominal CT reveals distention of the colon, more evident in the sigmoid loop (arrow), which extends from pelvis to upper abdomen, displaying a coffee-bean configuration , very suggestive of sigmoid volvulus.

Fig. 7

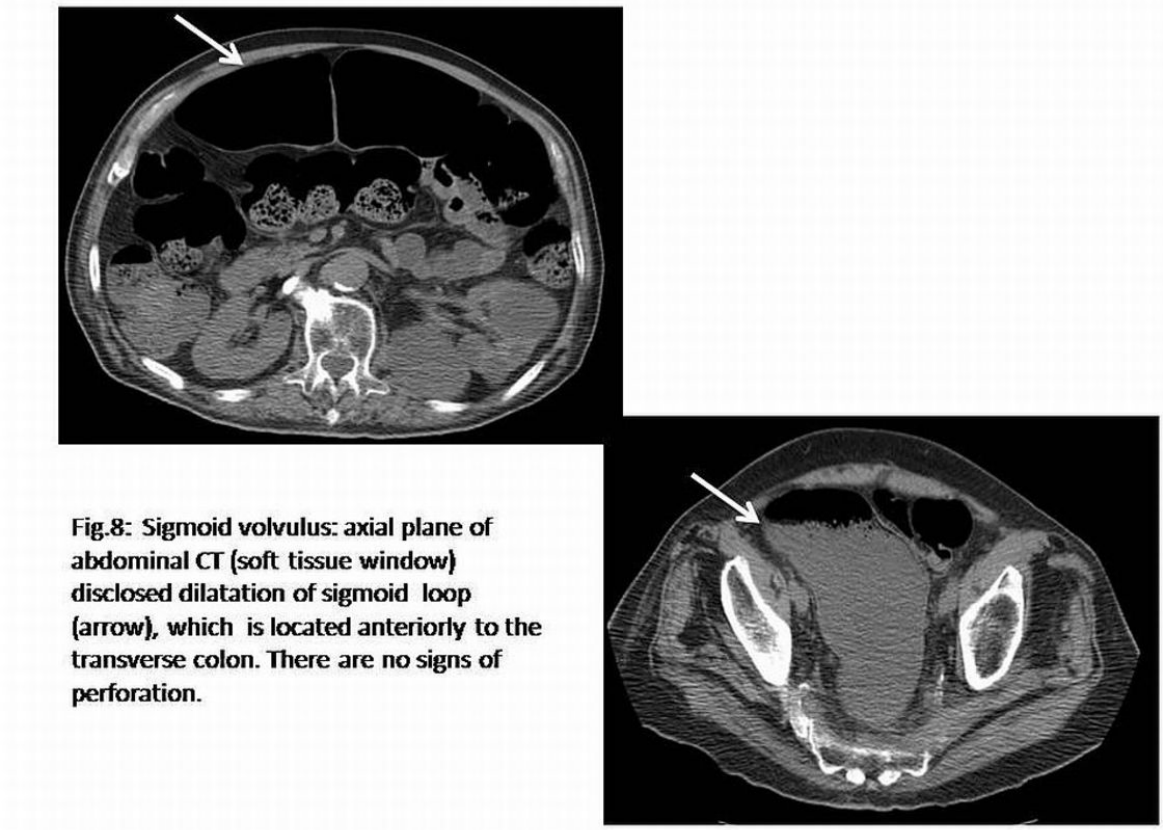

Fig.8: Sigmoid volvulus: axial plane of abdominal CT (soft tissue window) disclosed dilatation of sigmoid loop (arrow), which is located anteriorly to the transverse colon. There are no signs of perforation.

Fig. 8

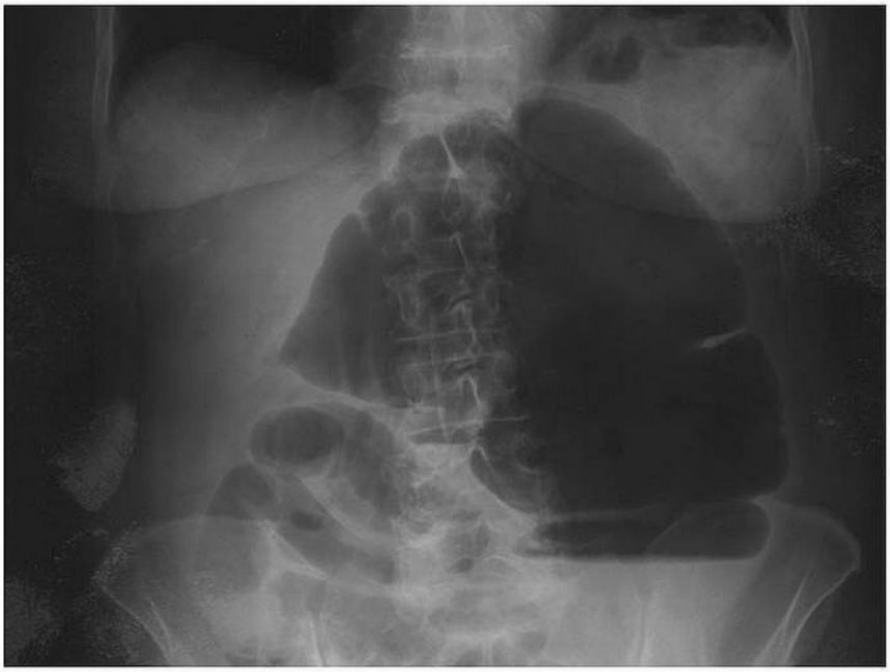

Fig.9: Cecal volvulus: this abdomen radiogram shows distended cecal loop with reniform configuration and only one air-fluid level. It is positioned in the upper left quadrant and there is also distension of the terminal ileum. Cecal haustra are preserved.

Fig. 9

Fig.10: Cecal volvulus: These axial planes of abdominal CT demonstrates ectopic position (upper left abdomen) and distension of the cecal loop (black arrow). Loops of terminal ileum are also dilated. Signs (white arrow) suggesting whirl sign.

Fig. 10

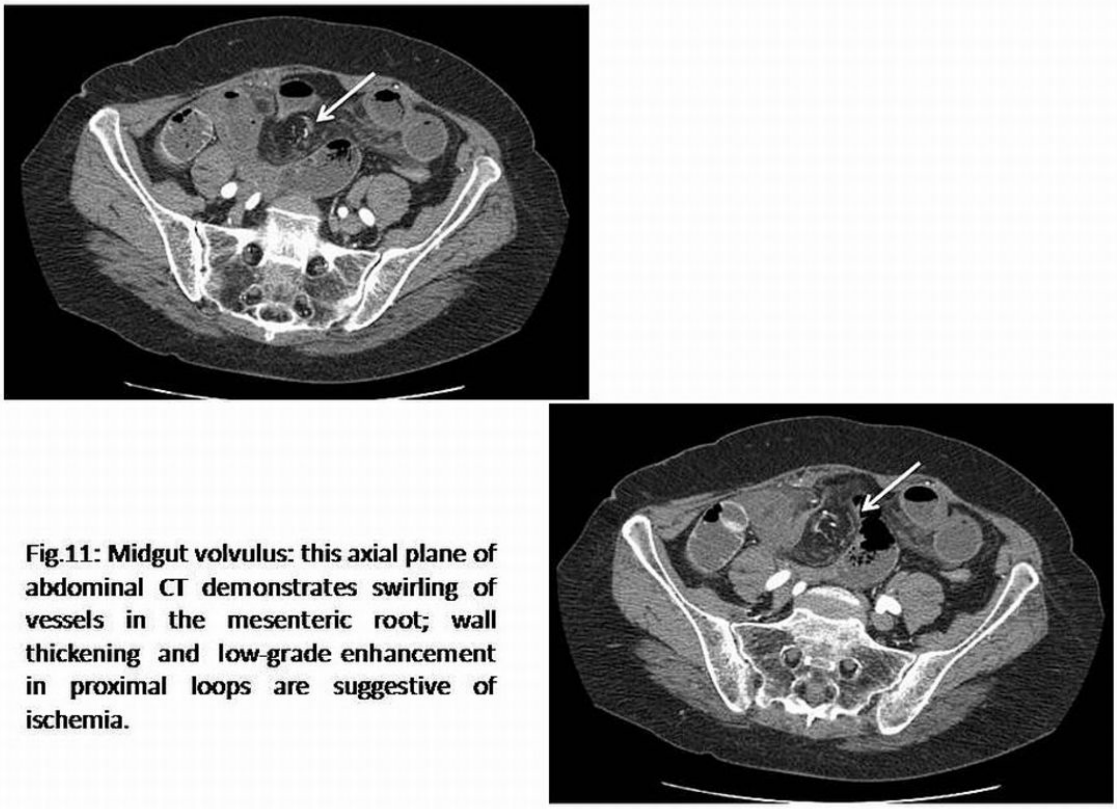

Fig.11: Midgut volvulus: this axial plane of abdominal CT demonstrates swirling of vessels in the mesenteric root; wall thickening and low-grade enhancement in proximal loops are suggestive of ischemia.

Fig. 11

Conclusion

Imaging tests are very helpful in the diagnosis of this clinical entity, allowing an early diagnosis and thus decreasing life-threatening complications.

Conventional radiology allows the etiologic diagnosis of most of the sigmoid and cecal volvulus cases. However, fluoroscopy continues to be the best imaging modality for diagnosis, characterization and treatment of the chronic gastric volvulus.

Finally, CT allows preoperative evaluation of the specific cause of IO as well as the evolution and severity of volvulus. It is also useful for detecting predisposing diseases in the pre-operatory period, which are important findings to planeate subsequent surgery.

Personal Information

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