Volvulus: clinical and radiologic characteristics

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Authors: R. Ramirez; Lorca/ES
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**Purpose**

The main objective of this study is to know radiologic features of volvulus of the gastrointestinal tract. Those signs common to all types of volvulus produced by volvulus physiopathology itself, and those specific features of volvulus in different localizations.

Advantages and disadvantages of different imaging techniques should be known, emphasizing those relevant findings that determine emergency of the treatment.

**Methods and Materials**

Cases of volvulus of gastrointestinal tract seen at our hospital during last three years and literature review.

**Results**

**INTRODUCTION:**

The vast majority of the gastrointestinal tract is immersed in intraperitoneal space wrapped in visceral peritoneum and attached to parietal peritoneum by ligaments and reflections, fixed and mobile at the same time. The elasticity of those ligaments can be higher in some individuals or change with age, due to surgery or pregnancy. In these cases intestinal mobility can be increased and abnormal movements may happen.

The term **Volvulus** is used when an abnormal movement produces a closed loop which rotates on itself.

The severity of clinical manifestations depends on the grade of twist. While in patients with partial torsion clinical presentation is insidious with intermittent and recurrent abdominal pain, in those with complete obstruction a high grade intestinal obstruction occurs thus becoming a true emergency. In almost all cases the clinical presentation is generally non specific and patients undergo to imaging evaluation.

Conventional radiography is usually the first imaging modality used due to its availability. It may show characteristic signs raising suspicion of volvulus, but findings are usually non-specific.
Flouroscopy studies may help confirm the diagnosis when diagnosis on plain film are in doubt and volvulus is suspected clinically. It is helpful when characteristics findings are detected, but it does not inform about complications.

MDCT has become the imaging modality of choice at some institutions for those cases of nonspecific gastrointestinal symptoms. It describes clearly not only the point of obstruction but detect complications (ischemia, perforation...). The findings of complicated volvulus include a less enhancement of a segment of wall, wall thickening, free fluid and free gas. These findings have to be note to orientate treatment management.

Althought the site of volvulus may vary some imaging findings are common to volvulus of different parts of the gastrointestinal tract:

- **"whirl sign"** (1): this is a typical sign of volvulus seen on MDCT. It consists in a soft tissue mass composed by several circular lines of different densities which correspond with fat, vessels and the collapsed point of dilated loops (Fig. 1 on page 9). It was first described by Fisher in midgut volvulus in a patient with intestinal malrotation. (2). Althought it is recognised it can be seen in other types of volvulus. Shaff et al described the whirl sign in sigmoid volvulus (3) and Frank et al in cecal volvulus (4). Some authors propose the thickness of the whirl can predict the degree of torsion.

- **"bird’s beak sign"**: characteristic appearence of the bowel at the twist, with progressive tapering of the afferent or efferent limb. Mucosal folds show a corkscrew aspect at the point of torsion. This is a feature classically described at fluoroscopy studies but it can be also found at MDCT. (Fig. 2 on page 10)

Most of these cases are life-threatening surgical emergencies due to high risk of vascular compromise. One exception is patients with no complicated sigmoid volvulus who are usually elderly with other co morbidities, for whom it may be recommended to treat first conservatively with tube decompression. Surgery is reserved for patients in whom conservative treatment fails or signs of complicated volvulus are detected (9). Another exception is gastric volvulus which may be partial and with lack of symptoms. In such cases clínical follow-up is indicated.

**COLONIC VOLVULUS**

Colonic volvulus is common cause of large bowel obstruction in adults.

Sigmoid volvulus is the most common type and account for 60-75% of all colonic forms, followed by cecal volvulus (20-33%), volvulus of transverse colon (2-4%) and splenic flexure (<1%). (5).
Sigmoid volvulus:

Demographics and pathology:

It is the most frequent type of colonic volvulus and gastrointestinal volvulus. This is due to this segment of colon is particulary mobile because it has its own mesentery. When an acquired or congenital narrow root of mesentery coexists with a long mobile sigmoid colon (as seen with sigmoid colonic redundancy which is frequent among those with high-fibre diets and in older patients), the prevalence of volvulus increases.

This type of volvulus is a particularly frequent cause of large bowel obstruction. It is the most frequent cause in developing countries because a high-fiber diet may cause sigmoid colon redundancy. In developed countries is the third cause, after neoplasm and diverticular disease, being more prevalent in older institutionalised patients.

Main subtypes:

1. mesentero-axial: (Fig. 3 on page 11): it is the most frequent type. Torsion occurs around its mesenteric axis and is usually counter clockwise.
2. organo-axial: sigmoid colon rotates on its longitudinal axis. (Fig. 4 on page 12) it is also known as physiological incomplete torsion. It is less common but a more benign form. Patients are usually asymptomatic and it could be an incidental finding in fluoroscopy. Spontaneous detorsion occurs commonly.

Radiologic features:

1: Conventional radiology:

- Common findings: signs of large bowel obstruction (dilated colon with absence of rectal gas).

- Characteristic findings:
  
  • disproportionate sigmoid enlargement as a large air-filled bowel loop with lost of haustral pattern, which arise from the pelvis and extends cranially. It may assume different appearances: inverted U-shaped or typical coffee bean shape ("coffee bean sign") (Fig. 5 on page 13).
  
  • "white stripe sign": produced by wall of interposed loops. (Fig. 6 on page 14)
  
  • if dilated sigmoid extends beyond the level of transverse colon it is called
    "northern exposure sign" (6).

2: Barium enema: beak sign can be detected at site of torsion (Fig. 7 on page 15).
It informs about the grade of obstruction: if the contrast material column show progressive tapering but can reach the proximal sigmoid it corresponds to an incomplete obstruction; if it shows abrupt stop there is a complete obstruction.

3: MDCT: findings described at the point of obstruction seen on other imaging modalities (coffee bean sign, white stripe sign, northern exposure sign and beak sign) are better characterizing on MDCT (Fig. 8 on page 16). Other imaging signs are specific for this imaging technique:

- whirl sign. (Fig. 9 on page 17)
- split wall sign: one transition point (at single limb of the distal sigmoid) with mesenteric fat between sigmoid wall of two segments affected (Fig. 10 on page 18). It occurs in incomplete volvulus. (7).
- X-mark-the-spot-sign: it is seen at complete volvulus. Two transition points are seen oriented to the whirl sign in opposite directions (Fig. 11 on page 19). (7).

Cecal volvulus:

**Demographics and pathology:**

It is the second more common localization of colonic volvulus and it accounts for 1-3% of all large bowel obstruction in adults.

The term cecal volvulus is not precise because in most of the cases torsion occurs at ascending colon, above ileo-cecal valve.

Predisposing factors include congenital anomalies of colonic fixation to retroperitoneum. (8).

It has been suggested that associated obstructive lesions in the distal colon can be a risk factor.

The common clinic presentation is an acute abdomen with colockily abdominal pain of sudden onset.

**Main subtypes:**

1. organo-axial: it accounts for 90% of types. Torsion occurs around longitudinal axisi of ascending colon. (Fig. 12 on page 20). Dilated cecum can remain at right inferior quadrant or may be displaced anywhere in the abdomen depending of the degree of dilatation and degree of torsion.
2. bascule type: cecum folds anteriorly to ascending colon without torsion at the point of flexion. Clinical management is similar to organo-axial form but imaging findings are different (whirl sign is not seen).

**Radiologic features:**

1: Conventional radiology: characteristic appearance on plain films is a dilated loop vertically oriented from the right inferior quadrant with the apex at the left superior quadrant. (Fig. 13 on page 21). This finding is often seen on conventional radiography and it can be enough for diagnosis. (10).

2: Barium enema: the contrast enters the decompressed colon until a point of stenosis with a beak appearance at the site of twist (Fig. 13 on page 21).

3: MDCT: this imaging modality described better those features seen on other techniques. (Fig. 14 on page 22). It clearly identifies the dilated loop as cecum. It is confirmed when it detects the cecal appendix attached to it and the terminal ileon at the concave verge of the kidney shaped dilated loop (Fig. 15 on page 23). Whirl sign can be seen. (Fig. 15 on page 23)

As high risk of necrosis is highly associated with this form of volvulus, signs of complication should be carefully assessed.

**Tranverse colon volvulus:**

It is a rare form of volvulus.

Clinical presentation is an acute abdomen. Conventional radiography has non specific signs and diagnosis is made at computed tomography (10). MDCT shows twisting of a segment of transverse colon on its mesentery, with characteristic features at the site of torsion, such as the beak sign, whirl sign...

**SMALL BOWEL VOLVULUS:**

*Demographics and pathology:*

In this entity a segment of bowel is obstructed in two points causing a closed loop which rotates on itself resulting in a volvulus.
Clinic presentation is that of small bowel obstruction with high rates of complications because mesenteric torsion leads to early impediment of mesenteric vascular supply, thereby causing bowel ischemia (46% of cases) (11).

It is more common in children with intestinal malrotation, but it is increasingly detected in adults who undergo to imaging study for small bowel obstruction.

Main subtypes:

• primary: no underling cause is detected. It is an unfrequent form. It is relatively more common in developing countries because high fiber-diets tend to enlarge the bowel mesentery. Clinical presentation is recurrent mild abdominal pain. (12).

• secondary: two main subgroups: a) patients with intestinal malrotation in which the root of mesentery is abnormally shorter and is commonly associated with congenital Ladd’s bands. This condition classically presents in neonatal period with intestinal obstruction. The older the patients is the more frequent it presents with vague abdominal symptoms (recurrent abdominal pain, malabsorption) or even asymptomatic, detected as an incidental finding on imaging studies. When intestinal malrotation produces clinic manifestation in adult life the most frequent presentation is a midgut volvulus (12). And b) patient without intestinal malrotation but with adhesions, internal hernias, congenital bands… which may provide a nodal point around which dilated small bowel may twist. These is the most common group of small bowel volvulus.

Radiologic features:

1: Conventional radiography: it shows non-specific findings of small bowel obstruction with multiples air-dluids levels on upright position proyection, raising the suspicion of high grade obstruction. (Fig. 16 on page 24)

2: fluoroscopic upper gastrointestinal examination: sign of malrotation can be detected: abnormal displacement of gastro-jejunal joint bellow and to the right of the L1 left pedicle (which is different of its usual localization to the left of L1 left pedicle).

Beak sign and corkscrew pattern of the mucosa can be detected at transition point.

3: MDCT:

• whirl sign: it was first described for this type of volvulus (2). ( Fig. 17 on page 25 , Fig. 18 on page 26 y Fig. 19 on page 27).
• spoke wheel sign: radial distribution of distended small bowel loops around thickened mesentery with converging vessels into the site of torsion. It is best appreciated in axial sections. (11)
• features of malrotation: right displacement of duodenum-jejunum joint and Treits’s ligament. And inverted position of superior mesenteric vein and artery (although normal vessel position does not exclude intestinal malrotation).
• findings of complicated volvulus. (Fig. 20 on page 28)

gastric volvulus:

demographics and pathology:

This entity was described in 1866 by Berti. It is an uncommon type of volvulus because the stomach is a relatively fixed portion of the gastrointestinal tract, attached by gastro-splenic, gastro-colic and gastro-duodenal ligaments to adjacent structures. Predisposing factors which may increase gastric mobility are increased laxity of supporting ligaments (congenital, in older patients…) and diaphragmatic defects (hiatal hernias, diaphragmatic hernias…)

main subtypes:

• organo-axial: (Fig. 21 on page 29). It is the most frequent form (59% of cases). Diaphragmatic defects predispose to this type. The stomach rotates on the axis that connects cardias to pylorus. The greater curvature displaces from inferior to superior. Rotation may be less than 180⁰ (partial torsion) and these patients usually lack clinical symptoms of obstruction. In such cases, it is more accurate to describe the stomach as having an organoaxial position rather than an organoaxial volvulus (10). When torsion is complete (>180⁰) rates of strangulation are high. Specific clinical findings suggesting a complete gastric volvulus are: severe epigastric pain, impossibility for vomiting and inability to pass a nasogastric tube to stomach, known as "Borchardt triad". (Fig. 23 on page 31).
• mesentero-axial: (Fig. 22 on page 30). It accounts for about 1/3 of cases. This form is not associated with diaphragmatic defects, and is more common in young patients. Stomach rotates on a vertical axis passing through the middle of the greater and lesser curvatures. The pylorus moves anteriorly and superiorly
• mixed form: combination of organo-axial and mesentero-axial types.

radiologic features:
1: Conventional radiography: In mesentero-axial type the stomach assumes a spherical aspect. On up-right position two air-fluid levels are observed: superior one is the antrum and inferior one is the fundus. (Fig. 23 on page 31)
Organoaxial form of gastric volvulus is more challenging to detect on plain films.

2: Fluoroscopy upper gastrointestinal examination: in complete forms there is an obstruction to contrast entry but non specific findings are seen at the transition point.

Ingested contrast material may pass into the duodenum if torsion is partial.

3: MDCT: it describes more accurate those findings seen on conventional radiography and fluoroscopy upper gastrointestinal study. (Fig. 24 on page 32 y Fig. 25 on page 33)

Chronic type may be an incidental findings on MDCT performed for other reasons.

**ILEOSIGMOID KNOT:**

It is also known as compound volvulus.

Predisposing factors are a hypermobility of small bowel with a long mesenteric root coexisting with a redundant sigmoid colon.

Small bowel loops are obstructed by sigmoid colon.

Radiographic findings include signs of small bowel obstruction with a dilated colonic loop at the pelvis (14 and 15).

**Images for this section:**
**Fig. 1:** Whirl sign.
Fig. 2: Bird’s beak sign.
Fig. 3: Drawing shows mesentero-axial sigmoid volvulus
Fig. 4: Drawing shows organo-axial sigmoid volvulus.
Fig. 5: Conventional radiography shows coffee bean sign.
**Fig. 6:** Conventional radiography shows white stripe sign.
Fig. 7: Barium enema in a patient with sigmoid volvulus shows beak sign.
*Fig. 8:* CT findings in sigmoid volvulus.
**Fig. 9:** Whirl sign on CT in two patients with sigmoid volvulus.
Fig. 10: Split wall sign

Partial obstruction in a mesentero-axial sigmoid volvulus:

One transition point is seen at distal sigmoid without obstruction point at proximal sigmoid. Mesenteric fat separating the two sigmoid walls.
Fig. 11: X-mark-spot sign
**Fig. 12:** Drawing shows organo-axial cecal volvulus
Fig. 13: Conventional radiography and barium enema in a patient with cecal volvulus
Fig. 14: CT findings in cecal volvulus
Fig. 15: CT findings in cecal volvulus

A: The dilated loop seen on plain film and barium enema (stars) is also appreciated on MDCT where it is confirmed it corresponds to cecum, because terminal ileum (dots) is seen connecting to its concave verge at ileo-cecal valve (arrow).

B: Whirl sign (circle) is seen adjacent to colon stenosis with beak appearance. (white arrow: ascending colon).
Fig. 16: Conventional radiography in a patient with small bowel volvulus
Fig. 17: Whirl sign on CT in two different patients with small bowel volvulus.
Fig. 18: CT findings in small bowel volvulus secondary to adhesions.
**Fig. 19:** CT findings in a small bowel volvulus secondary to an unfixed cecum.
**Fig. 20:** CT findings in a complicated small bowel volvulus.
Fig. 21: Drawing shows organo-axial gastric volvulus.
**Fig. 22:** Drawing shows mesentero-axial gastric volvulus.
Fig. 23: Borchardt’s triad.

Eighty two years old man with severe epigastric pain and impossibility for vomiting. Arrow in B shows inability to pass a nasogastric tube to stomach, known as "Borchardt triad". Plain film in up-right position shows two air-fluid levels: superior one is the antrum (long arrow) and inferior one is the fundus (stars). Mesentero-axial gastric volvulus was proven at surgery.
Fig. 24: CT findings in mesentero-axial gastric volvulus.

Two reformatted CT images in same patient as in fig 23. In A nasogastric tube is in the esophagus, being unable to enter in the fundus of the stomach (stars). Antrum (arrow) is located superiorly, above the fundus, in thoracic cavity, passing trough a paraesophageal hernia. (It has to be noted that this association is less frequent in mesentero-axial gastric volvulus than in organo-axial form). Red dot line in B draws the movement of the stomach, rotating on an axis which pass trough the middle of the greater and lesser curvatures (white line).
Fig. 25: CT findings in mesentero-axial gastric volvulus.
Conclusion

Volvulus of gastrointestinal tract are an overall uncommon pathology but clinical presentation is generally non-specific and patient undergo to imaging procedure, so typical findings should be known to prompt diagnosis and treatment.

Note should be made of complicated volvulus (aspect of intestinal wall and free fluid) as signs of more advanced disease and poorer prognosis.

References

Personal Information