Volvulus of the Gastrointestinal Tract: x-ray and CT imaging

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Learning objectives

To provide an overview of the imaging findings of volvulus of the gastrointestinal tract, including gastric, midgut, transverse colon, cecal and sigmoid volvulus, with emphasis on the role of x-ray and CT.
Background

Gastric Volvulus

The most frequently used classification system was proposed by Singleton, who described 3 types of gastric volvulus: organoaxial, mesenteroaxial and combination - unclassified.

Organoaxial volvulus is the most common variant, occurring in approximately 59% of cases. Because the duodenum and gastroesophageal (GE) junction are relatively fixed, the stomach rotates around the longitudinal axis, with the greater curvature being displaced superiorly and the lesser curvature located more caudally in the abdomen. The antrum rotates anterosuperiorly, and the fundus rotates posteroinferiorly. In adults, organoaxial volvulus most commonly occurs in the setting of a posttraumatic or paraesophageal hernia that allows the stomach to move abnormally along its long axis. If the volvulus is severe or complete, meaning that the twist is greater than 180°, gastric outlet obstruction occurs, and the stomach becomes dilated and fills with fluid. If positive oral contrast material is administered, it is retained in the stomach. However, many patients have less severe, incomplete or partial volvulus - a rotation less than 180°. In these cases, ingested contrast material may pass through the stomach and into the duodenum. Mesenteroaxial volvulus is much less common than organoaxial volvulus. It occurs when stomach rotates along its short axis, with resultant displacement of the antrum above the gastroesophageal junction. Rotation is usually partial (less than 180°) and is not associated with underlying diaphragmatic defect. Radiographic findings of gastric volvulus include herniation of a large portion of the stomach above the diaphragm, often with air-fluid levels (1,2).

Midgut Volvulus

Midgut volvulus is a different clinical entity and is most common in children; 60%-80% of those affected, present with bilious vomiting in the 1st month of life. Malrotation of the small bowel is the major predisposing factor for midgut volvulus. In a malrotation, there is abnormal fixation of the small bowel mesentery, which results in an abnormally short mesentery root. This allows the small bowel to twist around its mesentery, causing obstruction and possibly ischemia of the bowel. Conventional radiography may reveal the characteristic abnormal position of most of the small bowel in the right abdomen and the resultant abnormal location of the ligament of Treitz. On upper GI images, the ligament of Treitz normally is located at or to the left of the left L1 pedicle. On the contrary, in patients with malrotation, the ligament of Treitz is abnormally positioned, usually below and to the right of the left L1 pedicle. In the presence of a midgut volvulus, the twisted segment (usually a proximal segment) of small bowel has a characteristic corkscrew-like appearance on fluoroscopic images. Familiarity with the CT findings of midgut volvulus is important, because many patients present with nonspecific symptoms and are first evaluated with cross-sectional imaging. AT CT, a swirling of vessels in the mesenteric
root may be seen at the site of the volvulus. The abnormal relationship between the superior mesenteric artery and vein, an ectopic location of the majority of small bowel loops, and an abnormal position of the ligament of Treitz also may be seen. The superior mesenteric vein and artery may be appreciated, with the vein located to the left of the artery, which is the opposite of its usual orientation (1).

Cecal Volvulus

Cecal volvulus accounts for 25%-40% of all cases of colonic volvulus. Abnormal peritoneal fixation is a common anatomic variation that allows proximal colon mobility. Cecal volvulus may occur if there is an additional insult such as scaring, adhesions, or an abdominal mass that serves as a fulcrum for rotation. Classic abdominal radiographic findings include a focal round loop of air-distended bowel with haustral markings directed toward the left upper quadrant or mid abdomen. However, it is important to recognise that the cecum may be displaced anywhere in the abdomen. CT findings of a whirl, ileocecal twist, the X -marks-the spot sign, and the split-wall sign are specific for cecal volvulus. The twisting of mesenteric fat and vessels at base of cecal twist is known as the whirl sign (1,3).

Transverse Colon Volvulus

The transverse colon is the rarest site of colonic volvulus (<5%-10% of cases), but it is associated with the highest mortality. It occurs in the setting of abnormal fixation of a long transverse colon. Conventional radiography is seldom helpful in diagnosing this entity. As in cases of cecal volvulus, a contrast material enema study shows the characteristic beaklike tapering of the colon at the level of the twist. However, because volvulus of the transverse colon is rare and not usually expected, the diagnosis is often made at CT, which shows bowel obstruction and the classic mesenteric twist (1).

Sigmoid Volvulus

Radiographic findings that may be diagnostic of sigmoid volvulus, include a large air-filled bowel loop, which represents the sigmoid colon arising from the pelvis and extending cranially beyond the level of the transverse colon (the northern exposure sign). The most sensitive scanogram findings are absence of rectal gas and an inverted-U-shaped distended sigmoid followed by the coffee bean sign and disproportionate sigmoid enlargement (4).

The most sensitive cross-sectional findings are one sigmoid colon transition point and disproportionate enlargement of the sigmoid. The radiographic features include the "coffee bean " sign (the dilated sigmoid collon may have coffee bean-like shape). Similarly the "closed-loop" and "three-line" or "white-stripe" signs describe the U-shaped closed-loop appearance of the colon, which is dilated between the two points of obstruction at the site of the volvulus; and the oblique oriented vertical white lines that represent the opposed walls of the dilated bowel loop (the center line) and the outer walls of the bowel.
loop on either side. At CT, the abnormal position of the sigmoid colon and swirling of the mesentery at the level of the volvulus are visible (1,4).
Imaging findings OR Procedure details

This exhibit describes and illustrates the imaging findings for volvulus of the gastrointestinal tract. We present a comprehensive review of gastric (fig.1-4), cecal (fig.5-8) and sigmoid volvulus (fig.9-12). The imaging findings of transverse colon and midgut volvulus have been described, in Background section.
Fig. 1: Gastric volvulus: Organoaxial volvulus. Scanogram shows the stomach herniated into the chest (fig.1). Axial CT images (fig.2, fig.3, fig.4) show the upward rotation of the stomach along its long axis, which results in inversion of the greater curvature above the lesser curvature, and the twist point of the volvulus (black arrow).

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Fig. 2: Gastric volvulus: Organoaxial volvulus. Scanogram shows the stomach herniated into the chest (fig.1). Axial CT images (fig.2, fig.3, fig.4) show the upward rotation of the stomach along its long axis, which results in inversion of the greater curvature above the lesser curvature, and the twist point of the volvulus (black arrow).

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**Fig. 3:** Gastric volvulus: Organoaxial volvulus. Scanogram shows the stomach herniated into the chest (fig.1). Axial CT images (fig.2, fig.3, fig.4) show the upward rotation of the stomach along its long axis, which results in inversion of the greater curvature above the lesser curvature, and the twist point of the volvulus (black arrow).

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Fig. 4: Gastric volvulus: Organoaxial volvulus. Scanogram shows the stomach herniated into the chest (fig.1). Axial CT images (fig.2, fig.3, fig.4) show the upward rotation of the stomach along its long axis, which results in inversion of the greater curvature above the lesser curvature, and the twist point of the volvulus (black arrow).

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Fig. 5: Cecal volvulus: Scanogram shows a focal round loop of air-distended bowel with haustral markings displaced in the mid-abdomen, corresponding the dilated twisted cecum (black arrow) (fig.5). Axial CT images (fig.6, fig.8) show the dilated cecum in the mid-abdomen (black arrows), as well as the mesenteric twist (blue arrow) (fig.7). Note the mesenteric stranding and edema.

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Fig. 6: Cecal volvulus: Scanogram shows a focal round loop of air-distended bowel with haustral markings displaced in the mid-abdomen, corresponding the dilated twisted cecum (black arrow) (fig.5). Axial CT images (fig.6, fig.8) show the dilated cecum in the mid-abdomen (black arrows), as well as the mesenteric twist (blue arrow) (fig.7). Note the mesenteric stranding and edema.

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Fig. 7: Cecal volvulus: Scanogram shows a focal round loop of air-distended bowel with haustral markings displaced in the mid-abdomen, corresponding the dilated twisted cecum (black arrow) (fig.5). Axial CT images (fig.6, fig.8) show the dilated cecum in the mid-abdomen (black arrows), as well as the mesenteric twist (blue arrow) (fig.7). Note the mesenteric stranding and edema.

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**Fig. 8:** Cecal volvulus: Scanogram shows a focal round loop of air-distended bowel with haustral markings displaced in the mid-abdomen, corresponding the dilated twisted cecum (black arrow) (fig.5). Axial CT images (fig.6, fig.8) show the dilated cecum in the mid-abdomen (black arrows), as well as the mesenteric twist (blue arrow) (fig.7). Note the mesenteric stranding and edema.

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Fig. 9: Sigmoid volvulus: Scanogram shows a dilated sigmoid colon arising from the pelvis, with its apex in the right upper quadrant of the abdomen (black arrow). The interposed loops produce the white-stripe sign (yellow arrow) (fig.9). Note that the dilated sigmoid colon has a "coffee bean" -like shape. Axial CT images depict the twist region (pink arrow) (fig.11) and the two twisted loops (red and green arrow respectively) (fig.10, fig.11, fig.12)

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**Fig. 10:** Sigmoid volvulus: Scanogram shows a dilated sigmoid colon arising from the pelvis, with its apex in the right upper quadrant of the abdomen (black arrow). The interposed loops produce the white-stripe sign (yellow arrow) (fig.9). Note that the dilated sigmoid colon has a "coffee bean"-like shape. Axial CT images depict the twist region (pink arrow) (fig.11) and the two twisted loops (red and green arrow respectively) (fig.10, fig.11, fig.12)

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**Fig. 11:** Sigmoid volvulus: Scanogram shows a dilated sigmoid colon arising from the pelvis, with its apex in the right upper quadrant of the abdomen (black arrow). The interposed loops produce the white-stripe sign (yellow arrow) (fig.9). Note that the dilated sigmoid colon has a "coffee bean"-like shape. Axial CT images depict the twist region (pink arrow) (fig.11) and the two twisted loops (red and green arrow respectively) (fig.10, fig.11, fig.12)

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Fig. 12: Sigmoid volvulus: Scanogram shows a dilated sigmoid colon arising from the pelvis, with its apex in the right upper quadrant of the abdomen (black arrow). The interposed loops produce the white-stripe sign (yellow arrow) (fig.9). Note that the dilated sigmoid colon has a "coffee bean"-like shape. Axial CT images depict the twist region (pink arrow) (fig.11) and the two twisted loops (red and green arrow respectively) (fig.10, fig.11, fig.12)

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Conclusion

Volvulus of the gastrointestinal tract presents with acute or recurring abdominal pain in adults. It's important for radiologists to be familiar with various appearances of volvulus throughout the gastrointestinal tract to avoid life-threatening complications such as bowel ischemia and infarction.
References


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