Intestinal obstruction key. What should we look for?

Poster No.: C-1689
Congress: ECR 2013
Type: Educational Exhibit
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Keywords: Obstruction / Occlusion, Contrast agent-intravenous, CT, Abdomen
DOI: 10.1594/ecr2013/C-1689

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Learning objectives

To review etiology and imaging tests available in bowel obstruction, with special emphasis on computed tomography (CT).

To describe technique, indications and spectrum of findings of plain radiograph and computed tomography in bowel obstruction.

Background

Intestinal obstruction is a frequent cause of hospitalization and surgical consultation, representing 20% of all surgical admissions for acute abdominal pain.

The diagnosis is based on patient history, results of physical examination, laboratory tests and radiologic procedures.

A variety of radiologic procedures are available in the diagnosis of intestinal obstruction. Recent studies have demonstrated the superiority of CT in revealing the site, level, and cause of obstruction and in demonstrating threatening signs of bowel inviability.

Conventional radiograph remains the initial imaging method in patients with suspected intestinal obstruction.

DEFINITIONS

- **Functional (pseudoostruction).** Symptoms of mechanical obstruction in the absence of luminal occlusion or compression.
- **Mechanical.** A mechanical blockage arising from a structural abnormality that presents a physical barrier to the progression of intestinal contents.

Differential diagnosis of mechanical and functional intestinal obstruction:

- The presence of air-fluid levels in mechanical obstruction.
- The absence of transition point in functional obstruction.

Imaging findings OR Procedure details
IMAGING TECHNIQUES

The increased application of advanced modalities of abdominal imaging in the clinical context of intestinal obstruction, combined with assumption that most of these conditions resolve with nonsurgical treatment, imaging has become the primary focus in the treatment of patients with intestinal obstruction.

PLAIN RADIOGRAPHY

INDICATIONS

Plain radiography is the first imaging method in suspected intestinal obstruction due to its accessibility, low cost and capacity to distinct between a high-grade and a low grade obstruction.

TECHNIQUE

- **Abdominal radiograph in supine.** The election choice and if this is suggestive of obstruction, its not necessary doing another projection.
- **Abdominal radiograph upright.** It reserves for doubtful cases, when supine radiograph is not diagnostic. This projection can observe the existence of fluid levels.
- **Abdominal radiograph in prone.** To confirm absence of distal gas.

The last two projections are complementary in doubtful cases: to differentiate among paralytic ileus, pseudobstruction or mechanical obstruction, to discriminate between SB and LB obstruction, or to assess the obstruction grade.

COMPUTED TOMOGRAPHY (CT)

INDICATIONS

- When intestinal obstruction is suspected and the abdominal radiograph shows normal or equivocal signs (this happens in 20-30% of cases or more).
- Patients with obstructive symptoms that have a history of malignancy, or there is a palpable mass (discarding external hernia), inflammatory bowel disease or sepsis.
- Suspected complication requiring urgent surgical treatment (strangulation, perforation, peritonitis).
- Differentiate between paralytic ileus and mechanical obstruction.
- Bowel obstruction is diagnosed clinically and radiographically but additional information is needed to decide the appropriate treatment.

TECHNIQUE
• Our protocol of study using traditional single-detector CT include scans performed from the diaphragm to the pubic bone.
• Administration of intravenous contrast material (120 ml, 60 s scan delay, 3 ml/s rate).
• Intraluminal administration of contrast material is rarely necessary because the fluid and gas inherent in the bowel provide sufficient contrast.
• View images in the sagittal, coronal, and axial planes. Is particularly useful doing multiplanar and 3D reconstructions.

WHAT TO LOOK FOR IN IMAGING?

1) Establish the presence of obstruction.
2) Characterize the severity of the obstruction.
3) Identify the transition point.
4) Identify the cause of the obstruction
5) Simple or closed-loop intestinal obstruction?
6) Complications.

1. ESTABLISH THE PRESENCE OF OBSTRUCTION

PLAIN RADIOGRAPH

Small bowel obstruction (SBO):

Small bowel obstruction is characterized by dilated bowel loops proximal to the transition point and the presence of air-fluid levels depending on the severity.

Dilated small bowel loops with a caliber greater than or equal to 3 cm (greater than 2.5 cm increases the sensitivity) are pathological.

1. Complete SBO. The distal loops are collapsed, without distal gas and air-fluid levels are present. (Fig.1).

2. Incomplete or early complete. There are distal gas in the intestine, although in smaller amounts (Fig.1).

"Stack of coins sign": Distended loops with typical connivent valves outlined by intraluminal air (Fig.1)
"String-of-beads" sign: The distended fluid-filled loops, produces a linear appearance of small air bubbles between connivent valves. (Fig 2).

**Large bowel obstruction (LBO)**

If the diameter of the transverse colon is over 6 cm or the diameter of the cecum is more than 9 cm is considered pathological. There is a high risk of perforation if cecum diameter goes above 12 cm.

Air-fluid levels are less numerous than in SBO.

**COMPUTED TOMOGRAPHY FINDINGS**

CT criteria for intestinal obstruction are similar to plain radiography:

1. The presence of dilated small bowel loops (diameter > 2.5 cm from outer wall to outer wall) in SBO and dilated colon in LBO with the diameter of the transverse colon more than 6 cm, proximally to normal-caliber or collapsed loops distally.

2. The "String-of-beads sign" is also a CT finding of intestinal obstruction.

3. "Beak sign": The transition zone of obstruction is observed like a beak and indicates an abrupt transition point. (Fig. 3).

**2. CHARACTERIZE THE SEVERITY OF THE OBSTRUCTION**

The identification of severity in obstruction, is a very important point that contributes in subsequent therapeutic management:

A. Partial obstruction (high or low grade).

B. Complete obstruction.

**PLAIN RADIOGRAPH**

- **Low grade obstruction**: The radiograph shows bowel loops distension, with persistent distal gas and some fluid levels.
• Findings predictive of high-grade obstruction, are the presence of more than two air-fluid levels, air-fluid levels wider than 2.5 cm, and air-fluid levels differing more than 2 cm in height from one another within the same small bowel loop. (Fig. 1, 2).

**COMPUTED TOMOGRAPHY**

The severity of the obstruction is established according to the degree of distal collapse, proximal bowel dilatation and the contents of the bowel segments distal to the obstruction point.

In a high-grade obstruction, there is a 50% difference in caliber between the proximal dilated bowel and the distal collapsed bowel. If a high-grade obstruction has been present for several days, leads to complete evacuation of the contents of the bowel segments distal to the obstruction point. (Fig. 4, 5).

3. **IDENTIFY THE TRANSITION POINT**

The transition point is determined by identifying a caliber change between the dilated proximal and collapsed distal bowel loops.

Look for the presence of the "small bowel feces sign" because, it is usually present at the transition point. This sign consists of the presence of air bubbles mixed with loops content simulating fecaloid content of the colon.

"Beak sign": The transition zone of obstruction is observed like a beak. Indicates an abrupt transition point (Fig. 4, 5).

4. **IDENTIFY THE CAUSE OF THE OBSTRUCTION**

The use of a systematic approach based on the surgical and clinical history of the patient and epidemiologic data will assist in determination of the cause of the obstruction. Never forget that the answer is almost always in the transition point.

**Causes of intestinal obstruction:**

**A. Intrinsic causes**

- Inflammatory diseases.
- Neoplasia.
- Vascular lesions
- Hematoma.
- Intussusception

B. Intraluminal causes
- Gallstones
- Bezoars
- Foreign bodies

C. Extrinsic causes
- Adhesions
- Hernias
- Endometriosis
- Hematomas
- Volvulus

The main causes of intestinal obstruction are:

- **Small bowel**: adhesions, hernias, neoplasia and Crohn's disease
- **Large bowel**: carcinoma, volvulus and diverticulitis.

**ADHESIONS:**

Adhesions are the main cause of SBO (50-80%). Almost all of them are postoperative, with a minority being secondary to peritonitis and 5% are idiopathic.

- The diagnosis of SBO due to adhesions, is primarily one of exclusion, because adhesive bands are not seen at conventional CT.

- Abrupt change in the caliber of the bowel is seen without any associated lesion. (Fig.6).

**HERNIAS:**
Hernias are considered by some authors to be the second most common cause of SBO, responsible for 10% of cases.

- **External hernia** results from a defect in the abdominal wall at sites of congenital weakness or previous surgery (Fig. 7 y 8).
- **Internal hernia** occurs when there is protrusion of the viscera through the peritoneum or mesentery and into a compartment within the abdominal cavity.

Common CT findings of hernias include the transition point, bowel loop displaced and ingurgitated mesenteric vessels.

**CROHN DISEASE:**

SBO in Crohn disease can be a manifestation of two clinical situations that can occur in this disease:

**Acute phase:**
- Small bowel wall thickening with "double halo" appearance.
- Inflamed mucosa and serosa may markedly enhance after intravenous contrast administration, and the intensity of enhancement correlates with the clinical activity of the disease. (Fig. 9).

**Stenotic phase:**
- Bowel wall has homogenous attenuation at CT.

**INTUSSUSCEPTION**

Intussusception is a relatively rare condition in adults. Polypoid tumors, benign or malignant, are the most common cause of bowel intussusceptions in adults.

There are two patterns at CT, depending on the severity and duration of the disease:

-" Target sign". Consist of two concentrical rings or circles corresponding to the intussusceptum and intussuscipiens bowel separated for a cap of mesenteric fat. (Fig. 10)
  - Reniform mass.

**VOLVULUS**

Cecal volvulus:
A distended loop (cecum) located outside the pelvis in the left upper quadrant or middle abdomen is viewed on plain radiography. It may associate certain small bowel dilation without gas in distal colon.

**Sigmoid volvulus:**

- *The "coffee bean" sign* suggests sigmoid volvulus. The dilated segment of large bowel, converges towards the rotation point, simulating a coffe bean or an inverted U (Fig.11)

- "*The whirl sign*" indicates volvulus or intestinal malrotation. The mesentery and intestinal vessels rotate resembling a whirl. (Fig.11).

**NEOPLASIA**

**Large bowel:**

Is the most common cause of colonic obstruction. On CT shows a soft tissue mass and concentrically thickened colonic wall. (Fig. 12).

**Small bowel:**

Primary neoplastic causes of SBO are rare. Intrinsic small bowel neoplasms constitute less than 2% of gastrointestinal malignancies. When a small bowel adenocarcinoma manifests as SBO, it is usually at an advanced state and shows pronounced, asymmetric, and irregular mural thickening at the transition point.

**GALLSTONE ILEUS:**

Gallstone ileus is a rare complication of recurrent cholecystitis, caused by migration of a large gallstone, through a biliaryintestinal fistula with subsequent impaction in the duodenum (Bouveret syndrome), small bowel and less frequently in the large bowel.

**CT findings** are pathognomonic, corresponding to the radiographic triad of pneumobilia, ectopic gallstone, and intestinal obstruction. (Fig 13, 14).

**BEZOAR**

Bezoars are an unusual cause of acute abdomen The number of cases has increased since the introduction of gastric surgery. The obstruction caused by small bowel phytobezoars frequently occurs in the jejunum or proximal ileum.

**CT findings:** a bezoar appears as an intraluminal mass with an ovoid shape and a mottled gas pattern localized in the transition point.
**FOREIGN BODY**

Intestinal obstruction caused by a foreign body usually occurs in children or in mentally disabled patients. With increasing use of endoscopic capsules to evaluate inaccessible portions of the bowel, capsule retention in patients with small bowel luminal narrowing is a problem.

**CT findings** consist of intestinal obstruction with evidence of a foreign body at the transition point (Fig. 16).

**OTHER CAUSES**

Radiation enteritis (Fig. 17), mesenteric ischemic (Fig. 18), peritoneal carcinomatosis (Fig. 19).

**5. SIMPLE OR CLOSED-LOOP INTESTINAL OBSTRUCTION?**

**A. Simple obstruction** is considered when the bowel is occluded at one or several points along its course. The proximal part of the bowel is variably distended, depending on the severity and duration of the process.

**B. Closed-loop intestinal obstruction:** A bowel loop of variable length is occluded at two adjacent points along its course. **CT findings:**

1. Radial distribution of several dilated, usually fluid-filled bowel loops with U-shaped or C-shaped configuration, depending on the orientation of the closed loop.

2. Stretched and prominent mesenteric vessels converging toward the constricting point.

3. The "beak" sign is seen at the transition point.

**6. COMPLICATIONS:**

**A. Torsion.** The presence of constrictions of two adjacent bowel segments can lead to torsion of the loops. **CT findings:**

- "Beak sign" is seen at the site of the torsion.
- "Whirl sign" can be seen, reflecting rotation of the bowel loops around the fixed point of obstruction.

**B. Strangulation** is defined as a closed-loop obstruction associated with intestinal ischemia. This condition is seen in approximately 10% of patients with intestinal obstruction.

**C. Ischemia** can be caused by strangulation or secondary to partial or complete obstruction of the colon due to carcinoma (Fig. 20). **CT findings:**

- Thickening and increased attenuation of the affected bowel wall with a halo or "target sign."
- Mesenteric congestion.
- Pneumatosis intestinalis.
- Ascites.
- Asymmetric or delayed enhancement with lack of wall enhancement in advanced stage.

**D. Perforation.**

**Images for this section:**
Fig. 1: Abdominal radiographs in supine (A y B). (A) Complete obstruction. Note the absence of distal gas and dilated loops. (B) Incomplete intestinal obstruction without bowel dilatation and distal gas present. Note the presence of stack of coins sign (red arrow).
**Fig. 2:** Abdominal radiograph upright reveals high-grade obstruction. Note the presence of multiple air-fluid levels and "String-of-beads" sign (red arrow).
**Fig. 3:** Identification of the transition point (arrow) in an SBO secondary to postoperative adhesions. Coronal CT scan shows dilated small bowel loops. There is an abrupt change in caliber (arrow) between the proximal dilated bowel loops and collapsed distal bowel loops (Beak sign).
**Fig. 4:** High grade large bowel obstruction secondary to rectum cancer. Axial CT scan shows a 50% difference in caliber between the proximal dilated bowel and the distal collapsed bowel (arrow).
Fig. 5: (A) SBO due to ileum Crohn disease. Coronal CT scan shows dilated bowel loops with transition point simulating a beak (Beak sign).(B) LBO secondary to a rectal neoplasia.
**Fig. 6:** SBO secondary to adhesions after abdominal surgery. Coronal CT scan shows a change in bowel caliber at the transition zone (arrow). The involved bowel wall and lumen and the adjacent organs have a normal appearance, which excludes other possible causes.
**Fig. 7**: SBO secondary to an umbilical hernia. Axial and coronal CT scan shows small bowel dilatation. The transition point (arrow) is in the abdominal wall.
Fig. 8: SBO secondary to an inguinal hernia.
**Fig. 9:** SBO due to the acute phase of Crohn disease. (A) Coronal CT scans show dilatation of fluid-filled small bowel loops and a transition zone, with collapsed distal loops (red arrow). (B) Circumferentially thickened wall with the "double halo sign" (blue arrow).
Fig. 10: (A, B) Jejunojejunal intussusception. (C) Colonic intussusception due to a neoplasm of splenic flexure. Axial and coronal CT scan reveals an intussusception with a target-like appearance (red and blue arrows). The hypoattenuating area represents intussuscepted mesenteric fat (blue arrow).
Fig. 11: Sigmoid volvulus. (A) Abdominal radiograph in supine shows marked dilatation of the sigmoid colon. Note the coffee bean sign. (B) Axial TC scans shows mesentery and intestinal vessels rotate resembling a whirl (red arrow).
**Fig. 12:** Sigmoid colon stenosing neoplasm. Axial and coronal CT scans shows a soft tissue mass and concentrically thickened sigmoid wall with secondary large bowel obstruction (red arrow) and pneumatosis intestinalis (blue arrow).
Fig. 13: Gallstone ileus. Axial and coronal CT scans shows the migration of a large gallstone (blue arrow), through a biliaryintestinal fistula (red arrow) with subsequent impaction in the sigmoid colon.
Fig. 14
Fig. 15: Small bowel obstruction caused by a bezoar. Coronal CT scan shows dilated, fluid-filled small bowel loops with an abrupt transition point secondary to an intraluminal mass with mottled gas pattern (arrow). These findings are consistent with a bezoar, which was confirmed surgically.
Fig. 16: SBO secondary to a foreign body. Axial and coronal CT scan shows distended small bowel loops, with evidence of a foreign body (gastrostomy catheter) at the transition point (arrows).
Fig. 17: SBO secondary to radiation enteropathy. Axial and coronal CT scans shows distended small bowel loops with small bowel mural thickening (arrow).
Fig. 18: Acute mesenteric ischemia with bowel obstruction and secondary perforation.
**Fig. 19:** Colonic neoplasm with a left paravesical implant and secondary small bowel obstruction. Axial and coronal CT scans shows the peritoneal implant (arrows) and distended small bowel loops.
Fig. 20: Colonic ischemia secondary to partial obstruction of the colon due to sigmoid carcinoma. Axial and coronal CT scans show thickening and increased attenuation of entire colon with important dilatation secondary to a sigmoid carcinoma. Surgery confirmed that it was a complete colonic ischemia.
Conclusion

- The diagnosis of bowel obstruction is based on a complete medical history and appropriate physical examination, supported by an imaging compatible.
- Conventional radiography remains the initial method of imaging in patients with suspected small bowel obstruction.
- The superiority of CT in revealing the site, level, cause, and severity of intestinal obstruction, makes this modality an important additional diagnostic tool that provides important information on the therapeutic management.

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