Learning objectives

• Recognize imaging features of small-bowel obstruction (SBO);
• Propose an algorithmic approach to SBOs;
• Review SBO’s complications.
Background

Acute SBO is a common clinical condition that occurs secondary to mechanical or functional causes, and continues associated with a significant morbidity and mortality [2]. About 12-20% of all surgical admissions in an acute abdominal scenario are due to SBO [1,2], and accounts for 80% of all intestinal tract obstruction[3]. In the Western world, postsurgical adhesions represent 75% of SBOs[2,3], whereas in developing nations, 80% of SBOs are derived from an incarcerated hernia, but only 10% are caused by adhesions [3].

If a low-grade partial obstruction is suspected, oral contrast studies are preferred. If a complete or high-grade obstruction is suspected, CT is the technique of choice and it does not require oral contrast material because the retained intraluminal fluid serves as a natural negative contrast. The CT presentation consists of dilated bowel loops proximal to the obstruction, with normal-to-collapsed loops distally.

A systematic approach is needed to achieve an accurate diagnosis, establish SBO's severity, site, and assess the presence of strangulation.

In this poster the radiologic features of SBO, its complications and its management are reviewed using the literature. Imaging findings of some its etiologies are discussed, with special focus to adhesions, hernias, neoplasms, intussusception, radiation enteritis, gallstone ileus and vascular causes.
Findings and procedure details

Imaging has assumed a key role in assisting the therapeutic decision of the surgeon in cases of SBO [1,2], helping him to determine whether early laparotomy is needed or whether a nonsurgical management should be tried [2].

Clinical and laboratorial findings are usually nonspecific and unreliable at differentiating simple mechanical obstruction from strangulated bowel.

Hence, knowing the primordial role of imaging in this process, we should firstly determine if the small bowel is obstructed, than evaluate its degree, location and possible causes of SBO. Finally we should address if strangulation, or other complications are present [1,2].

We will now review the role of plain films, sonography and CT in the evaluations of SBOs.

Findings at Plain Abdominal Radiography:

Even though plain films are only diagnostic in 50%-60% of cases[1,2,3], this modality continues to be the first step in the imaging evaluation of these patients, due to its wide availability and lower cost [1,2]. Radiographs have been shown to be sensitive for high-grade but not low-grade obstructions [2].

The major radiographic signs that allow distinction between a high and low-grade SBO are:

- maximal distended loops of bowel greater than 3 cm in diameter [1,2] disproportionate to distal small bowel or colon loops [3];
- collapsed colon loops [2] and/or bowel loops exceeding 50% of the caliber of the largest visible colon loop [1];
- 2.5 times more the number of distended loops compared with of the number of normal loops;
• thickened bowel wall and signs like "the string-of-pearls" sign (related to small bubbles trapped between the valvulae conniventes) may also be identified in these situations [2,3];
• air-fluid levels wider than 2.5 cm [1,3];
• air-fluid levels differing more than 2 cm in height from one another within the same loop (strong evidence of obstruction) [1,3].

Strangulation may be suggested by edematous folds, pneumatosis intestinalis, and aeroportia, but these features are rarely seen.

Except for inguinal hernias and gallstone ileus, the cause of obstruction is often non perceptible on plain films.

In conclusion, if there is a high clinical suspicion of obstruction, additional imaging is required even if radiographs are reported to be normal.

**Findings at Sonography:**

Since the small bowel loops are usually filled with gas, sonography has a limited role in the evaluation of SBO, resulting in nondiagnostic sonograms. Since adhesions are the most common cause of mechanical SBO in the Western World, the fact that they are not detected with this technique also limits its role.

However, sonography is frequently used in places where the availability of CT is limited[1] and in pediatric institutions. Hence, when bowel segments proximal to the obstruction are dilated and fluid-filled, these loops may be used as a sonic window, not only for recognizing the level of obstruction, but also in some cases to determine the etiology of the obstruction [1] Causes like external hernias, intussusception, Crohn disease, bezoars, and tumors can be depicted with this method.

At sonography, bowel obstruction is presumed when:

• the fluid-filled lumen of small bowel loops is dilated to more than 3 cm;
• the length of the dilated segment is more than 10 cm and peristalsis is increased - showing to-and-fro / whirling motion of the bowel contents.
The level of obstruction may be determined by the location of the bowel loops and the pattern of the valvulae conniventes.

A severe obstruction may also be suspected when there is free fluid between distended bowel loops, aperistalsis, and wall thickening (>3 mm) in a distended fluid-filled loop, suggesting bowel infarction.

Findings at MDCT:

CT is the technique of choice for several reasons. MDCT can provide answers when assisting the therapeutic decision of the surgeon in cases of SBO, as nowadays it is a fast method that allows the assessment of extramural areas and does not require oral contrast material, since the retained intraluminal fluid serves as a natural negative contrast agent [1,2].

CT criteria for SBO are:

- small bowel loops with a diameter wider than 2.5 cm (from outer wall to outer wall) proximally to collapsed or normal-caliber loops [1,2].
- presence of a transition point, which often resembles a beak ("beak sign") - present in about 60% of simple SBOs [2,3]. According some authors, when isolated and without other evidence of lesions, this finding is highly suggestive of adhesions as the cause of obstruction [3].
- presence of the "string-of-pearls" sign, already described above (see plain film)
- "small bowel feces" sign, with feculent matter mixed with gas bubbles precociously seen within a dilated segment of small bowel[3]. This results from stasis and it is present in about 82% of SBOs [2]

In the effort of diagnosing high-grade obstructions, CT has high sensitivity and specificity, namely 81-94% and 96%, respectively. However, when approaching all grades of SBO, the sensitivity of CT decreases dramatically to 64% and specificity to 79%. Therefore, as already mentioned CT is not ideal for diagnosis of low-grade or subacute obstructions and should be complemented by a contrast study [2].

If a contrast medium is used, we may infer a complete obstruction, when analyzing delayed scans obtained at 3-24 hours if there is no passage of contrast medium beyond the point of obstruction [2].
High-grade partial SBO may be suggested if there is diluted oral contrast material in the distended proximal bowel and minimal contrast material in the collapsed distal loops, due to the stasis and delay in the passage of the contrast medium [1,2].

CT enteroclysis is mainly used in patients with clinically suspected low-grade SBO, owing to its ability to challenge the distensibility of bowel loops. However, CT enteroclysis may also be used in high-grade obstructions if relevant management questions were not answered by conventional CT.

Contrast-enhanced CT has also the capacity to reveal whether there is an associated intestinal ischemia due to strangulation, with reported sensitivities as high as 90%. Although the following signs are insufficiently sensitive individually, they are highly suggestive of ischemia when found together:

- thickened bowel wall;
- ascites;
- increased attenuation of bowel wall on noncontrast scans;
- the target sign - a trilaminar appearance of the bowel wall;
- poor or absent enhancement of bowel wall;
- pneumatosis intestinalis;
- gas in mesenteric or portal veins;
- the whirl sign - a twisting of the mesenteric vasculature signifying a volvulus;
- tortuous engorged mesenteric vessels;
- mesenteric hemorrhage.

SUGGESTED ALGORITHMIC APPROACH TO SBOs

If plain films reveals signs of an unequivocal SBO pattern, and a high-grade partial or complete SBO is suspected, some authors advocate that a surgical evaluation should be promptly performed [1]. However, if other treatment options are being considered, assessment of the severity and cause of the obstruction may become the priority. CT is the cross-sectional imaging method for evaluation of these acute situations. If CT is unavailable, sonography may be useful [1].

On the other hand, if the initial findings were normal, equivocal, or suggestive of a low-grade partial SBO, CT enteroclysis or other exam that challenges the distensibility of the
small bowel, may be recommended, as these exams often highlight the effects of mild obstructions.

**Signs that favor a** high-grade SBO versus incomplete obstruction:

- although controversial some authors say that the presence of "small bowel feces" sign (already described above - see CT) is in favor of high grade obstruction [1];
- 50% difference in caliber between proximal dilated and distal collapsed loops;

**The Transition Point**

A schematic methodology is recommended to recognize the caliber variation between the dilated proximal and collapsed distal small bowel loops:

- We should initiate in a retrograde mode, at the rectum and continuing proximally to the cecum, ileum, and jejunum. If the transition point is identified proximally (jejunum or duodenum), we should try using an anterograde method, starting at the stomach [1].
- Search for the existence of the "small bowel feces" sign - if present, the transition point is near.

**Cause of the Obstruction**

- Firstly, we should differentiate it from an adynamic ileus, which has diffuse bowel dilatation without a transition point, than we should try to exclude a colon's obstruction - etiology, symptoms, and treatment differ [1,5].
- Considerate that the patient's history and epidemiologic information will help in the differential diagnosis of the several causes of SBO.
- **Intrinsic bowel lesions** usually manifest as localized mural thickening, at the transition point.
- **Extrinsic causes** are seen adjacent to the transition point and often associated with extraintestinal findings.
- Most **intraluminal causes** manifest as endoluminal findings different from those of the remaining enteric content.

**Extrinsic Lesions:**
Adhesions
External hernias
Internal hernias
Hematoma
Endometriosis

**Intrinsic Lesions:**

**Intussusception**

**Tumors:**
Adenocarcinoma
Metastasis
Gastrointestinal stroma tumor

**Inflammatory lesions:**
Crohn disease
Tuberculosis
Eosinophilic gastroenteritis

**Vascular lesions:**
Radiation enteropathy
Ischemia

**Hematoma:**
Trauma
Anticoagulants
Luminal Lesions:

Gallstones

Bezoars

Foreign bodies

**Table1-** represents some SBO causes. Source - adapted from reference [9].

Intrinsic Causes of SBO

Neoplasms:

- primary neoplastic causes of SBO are rare[1], and even in patients with known malignancy about one third have a benign etiology [4];
- Small bowel involvement by metastatic cancer is more common than involvement by primary neoplasms, since less than 2% of gastrointestinal malignancies are intrinsic to small bowel and when a small bowel adenocarcinoma manifests as SBO, it is usually at an advanced state [1];
- signs that could favor this etiology are a pronounced, asymmetric, and irregular mural thickening at the transition point [1].

Intussusception:

- Although this is a major cause of SBO in children [3], it is rare in the adult population[5], accounting for less than 5% of SBOs [1];
- this phenomenon occurs when a segment of bowel telescopes within the lumen of a contiguous segment [5] and include intussusceptions with different lead-points, like secondary to neoplasms, adhesions, Meckel diverticulum, mesenteric nodes, or foreign bodies. Transient ones are not usually associated with this condition.
- At CT, distinguishing bowel-within-bowel configuration, is pathognomonic for intussusception, with or without mesenteric fat and vessels surrounding it.

Radiation Enteritis:

- Its usually a chronic complication that is established as soon as 1 year after radiation treatment. It results in transmural injury of the bowel wall and
progressive vasculitis, due to thrombosis, and various degrees of ischemia and necrosis. This process originates luminal narrowing and eventually end in bowel obstruction. These effects of chronic radiation are typical for targeted pelvic structure, with ileal loops being the most affect[1] and are usually related to the total dose of radiation received as well as the total volume of tissue irradiated[6];

• loops are affected not only by adhesive and fibrotic changes in the mesentery, but also by luminal changings like narrowing and dysmotility;
• CT may also reveal an angulated bowel wall, secondary to adhesions and mesenteric retraction. It is also possible to find an abnormal enhancing pattern of the thickened bowel wall, caught in the radiation field.

Vascular Causes:

• bowel ischemia may occur secondary to complications in the mesenteric vascular bed and some authors report this cause to be as frequent as 5% [8].
• contrast-enhanced CT may show either non-enhancing or noncircumferential asymmetric wall enhancement of the involved loops.
• advanced cases may show signs of pneumatosis and aeroportia.

Extrinsic Causes of SBO

Adhesions:

• the most common cause of SBO [1-4] in the Western World( 50%-80% of all cases).
• the majority are postoperative (surgery doesn't need to involve de small bowel) [4]. Hence, eighty percent of adhesions arise after surgery while 15% are due to peritonitis, and the remainder are either congenital or of uncertain cause [8].
• although the diagnosis of SBO due to adhesions may be one of exclusion, because adhesive bands are hardly perceived at CT, one may see a sharp bowel angulation at the site of obstruction as far as this finding is isolated, without any associated mass lesion, significant inflammation, or bowel wall thickening at the transition point [1,4].

Hernias:
there are many types of hernias, which are considered the second most common cause of SBO by some authors [1,8], and in developing countries they are considered the foremost cause.

hernias are classified as external or internal, and are further named according to the orifice through which bowel protrudes [1,4,8].

abdominal and pelvic wall hernias account for the majority of external hernias and occur at sites of previous weakness, either congenital or acquired [1]. Although the precise description of each hernia is beyond the scope of this poster, we review the most common ones, as groin (inguinal and femoral), ventral (umbilical, paraumbilical, epigastric, and hypogastric), lumbar, and incisional hernias [7].

An internal hernia is less common and occurs when the bowel loops protrude through the peritoneum or mesentery and into a compartment within the abdominal cavity [1].

**Intraluminal Causes of SBO**

**Gallstone Ileus:**

- According some authors it causes nearly 24% of small bowel obstructions in patients over the age 70 [3];
- The majority gallstone ileus is derived from the migration of a large gallstone through a biliaryintestinal fistula, with subsequent impaction at the distal ileum;
- This condition is classically associated with the classic Riegler triad sign, corresponding to SBO, pneumobilia and a distal small bowel calcification - although all three findings together are uncommon [1].

**Establishing weather SBO is Simple or Complicated** may have a parallel in the exclusion of closed-loop obstructions.

In simple SBOs the bowel may be occluded at one or several points along its course, and the proximal part of the bowel is variably distended, depending on severity and duration of the process.
On the other hand, when a bowel loop of variable length is occluded at two adjacent points along its course, we talk about a closed-loop obstruction. In these cases, the occlusion might be partial or complete and CT may characteristically reveal several dilated and radially fixed fluid-filled bowel loops, assuming a radial distribution[4], like an U or C-shaped configuration [1,4], with stretched and prominent mesenteric vessels converging toward the point of torsion. A small bowel volvulus may also result from the presence of two constrictions in adjacent bowel segments, since this condition may lead to torsion of the loops around a narrow pedicle. A "beak sign" and "whirl sign" - already described above - may be seen in this situations, which reflects the rotation of the bowel loops around the fixed point of obstruction.

When a closed-loop obstruction is associated with intestinal ischemia we talk about a possible strangulation, a condition seen in approximately 10% of patients with SBO. This situation is associated with a high mortality rate and occurs mainly when there is some delay establishing the right diagnosis and surgical treatment. CT has a detection rate ranging from 63%-100%. Although not specific of strangulation, some signs may be highly suggestive when together, and are ultimately caused by an impairment of blood supply [3] such as thickening (>3 mm) and increased density of the involved bowel wall, resulting in a halo or "target sign" due to the wall edema[3], and pneumatosis intestinalis" and aeroportia. However some authors consider the lack of wall enhancement as the most specific sign [3] although asymmetric or delayed enhancement has also been described in these situations [1]. Haziness or obliteration of the mesenteric vessels may be associated with fluid and hemorrhage in the mesentery.
**Fig. 1:** Coronal contrast-enhanced CT scan shows dilated small bowel loops and a transition point secondary to postoperative adhesions.

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Fig. 2: Axial contrast-enhanced CT scan shows small bowel feces sign in a patient with SBO secondary to postoperative adhesions.

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Fig. 3: Image courtesy of Eric Delabrousse, MD. Axial contrast-enhanced CT scan shows obstruction secondary to adhesive band. "Fat notch" sign (arrow), corresponding to lateral compression of bowel by extraluminal band.

Fig. 4: Axial contrast-enhanced CT scan shows SBO secondary to an inguinoscrotal hernia.

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Fig. 5: Coronal contrast-enhanced CT scan shows SBO secondary to an inguinoscrotal hernia.

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Fig. 6: Coronal contrast-enhanced CT scan shows Bouveret syndrome.

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Fig. 7: Coronal contrast-enhanced CT scan shows Bouveret syndrome.

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Fig. 8: Coronal contrast-enhanced CT scan shows gallstone ileus and choledocholithiasis.

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Conclusion

Acute SBO is a common clinical condition and is still associated with a significant morbidity and mortality. Imagers have an important function and contribute to the best therapeutic decision, by revealing if and where is the bowel obstructed, the obstruction severity, causes and evaluating possible signs of strangulation.
References


