CT of blunt abdominal trauma: Findings of hollow organs' injury and perforation

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Learning objectives

To provide an overview of the imaging findings of hollow organs' injury and perforation after blunt abdominal trauma with emphasis on the role of CT.
Background

*Bowel and mesenteric blunt trauma*

Bowel and mesenteric injuries are detected in 5% of blunt abdominal trauma patients at laparotomy and are the third most common type of injury from blunt trauma to abdominal organs. The common sites of blunt trauma injury in the small bowel are the proximal jejunum, near the ligament of Treitz, and the distal ileum, near the ileocecal valve [1].

As the last years nonsurgical management of liver and spleen injuries is preferred, it is important to exclude concurrent presence of significant bowel or mesenteric injury, because that would make conservative treatment inappropriate and exploratory laparotomy demanding. Significant bowel injury is defined as either a complete tear of the bowel wall or an incomplete tear that involves the serosa and that extends to but does not involve the mucosa. Nonsignificant bowel injuries include a hematoma and a tear limited to the serosa. While, significant mesenteric injuries include active mesenteric bleeding, disruption of the mesentery, and mesenteric injury associated with bowel ischemia. An isolated mesenteric hematoma is considered non-significant[1].

*Major bladder trauma*

Right classification of injury is important for correct treatment. Intraperitoneal bladder ruptures (type 2) and combined intraperitoneal and extraperitoneal ruptures (type 5) require laparotomy. Contusions (type 1) and interstitial injuries (type 3) are managed conservatively with Foley catheterization. Most extraperitoneal ruptures (type 2) may be treated with catheter drainage if the urine clears of blood, the catheter functions well, and the bladder neck is not injured; otherwise, formal surgical repair is necessary [4].

*Female genital tract*

A patient with severe pelvic trauma is at risk for a spectrum of pelvic injuries including the follow: Pelvic hematoma, rectal, vaginal injury and bladder injury [Fig.8]. Therefore when identifying one of those injuries the radiologist should be alert and search for coexistent trauma involvement of other organs.
Findings and procedure details

*Bowel and mesenteric blunt trauma*

*Specific CT findings of bowel and mesenteric injuries include:*

- Bowel wall discontinuity,
- intraperitoneal and mesenteric air [Fig.1,5],
- intraperitoneal extraluminal contrast material [Fig.2],
- extravasation of contrast material from mesenteric vessels, and
- evidence of bowel infarct [1].

*Specific signs of mesenteric injury are:*

- Vascular beading, abrupt termination of mesenteric vessels and mesenteric extravasation [1].

*Less specific signs of bowel and mesenteric injuries include:*

- focal bowel wall thickening [fig.3],
- abnormal bowel wall enhancement.
- mesenteric fat stranding [Fig.4] with focal fluid and hematoma [fig.6,7], and
- intraperitoneal or retroperitoneal fluid [fig.6,7] [1].

*Things To Remember*

1. There is a potential for a false-positive diagnosis of a bowel perforation when evaluating extraluminal contrast material, in the case of an intraperitoneal rupture of urinary bladder.

2. Foci of intraperitoneal and extraluminal air can also be observed in other cases except bowel perforation, such as mechanical ventilation and pulmonary barotraumas, peritoneal lavage prior to CT, pneumothorax, chest injury, entry of air via the female genital tract (fallopian tubes), and intraperitoneal laceration of the bladder secondary
to cystography. Furthermore, presence of air located in the abdominal wall, can be misinterpreted as true pneumoperitoneum [1].

3. Bowel wall thickening is a less specific finding. Diffuse small-bowel wall thickening usually is representative of systemic volume overload or hypoperfusion complex (shock bowel). A helpful finding is the attenuation of the bowel wall, as attenuation similar to that of water is suggestive of shock bowel [1].

4. Increased bowel wall enhancement may represent bowel injury with vascular involvement or may be part of the hypoperfusion complex. Irregular increases in bowel wall enhancement after intravenous contrast administration is suggestive of full-thickness injury, whereas areas of decreased contrast enhancement can represent ischemic bowel [1].

5. The location of the fluid may indicate the location of injury. Retroperitoneal fluid may indicate injury of a retroperitoneal segment of bowel. [1].

6. Abdominal wall injury.-There is a significant association between abdominal wall injury (tear, hematoma, or "seat belt" sign [subcutaneous fat stranding along the course of the fastened seat belt]) and bowel and mesenteric injuries [2].

7. Often a severe trauma involving multiple organs injuries may cause findings to be overlooked and others to be misinterpreted. It has been observed that the presence of a finding on a radiologic study is more likely to be missed if another imaging finding is identified first [3].

Major bladder trauma

Classification of bladder injury [4]

- Type 1: Bladder contusion is defined as an incomplete or partial tear of the bladder mucosa. The imaging findings are normal.

- Type 2: In intraperitoneal rupture, CT cystography demonstrates intraperitoneal contrast material around bowel loops, between mesenteric folds, and in the paracolic gutters.

- Type 3: Interstitial bladder injury is defined as an intramural or partial-thickness laceration with intact serosa. In the interstitial injury the findings include intramural hemorrhage and submucosal extravasation of contrast material without transmural extension.

- Type 4: In extraperitoneal rupture, the path of extravasated contrast material is variable: Extravasation is confined to the perivesical space in simple extraperitoneal ruptures (type 4a) [fig.8], whereas in complex extraperitoneal ruptures (type 4b), contrast material extends beyond the perivesical space and may dissect into a variety of fascial planes.
and spaces [fig.5]. Extraperitoneal rupture is the most common type of bladder injury (80%-90% of cases) [6].

- Type 5: Combined intra- and extraperitoneal rupture usually demonstrates extravasation patterns that are typical for both types of injury.

CT cystography details

Filling the bladder with a minimum of 250-300 ml of contrast material is necessary to safely rule out a tear. Mee et al [5] suggested that retrograde filling of the bladder with this volume of contrast material prior to routine abdominopelvic CT may improve detection of extravasation.

Female genital tract

A patient with severe pelvic trauma is at risk for a spectrum of pelvic injuries including the follow: Pelvic hematoma, rectal, vaginal injury [fig.8] and bladder injury. Therefore when identifying one of those injuries the radiologist should be alert and search for coexistent trauma involvement of other organs.
**Fig. 1:** CT scan reveals intramural air in the jejunum (light blue arrows) and foci of intraperitoneal air that have escaped from the jejunal perforation (white arrows).

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Fig. 2: Abdominal CT scan reveals free intraperitoneal contrast material outlining the spleen, which is a CT finding with high specificity for bowel wall injury.

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**Fig. 3:** CT scan in a patient after blunt abdominal trauma demonstrates thick-walled jejunal loop (black arrow) which is indicative for bowel-wall injury.

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Fig. 4: Axial CT image demonstrates rectal perforation after blunt abdominal trauma. The wall thickening of the rectum, the intramural air (black arrow), the mesentery infiltration (white arrow) and the foci of intraperitoneal air that have escaped from the rectum (not shown in this image) are highly suggestive of a rectal perforation as the diagnosis.

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Fig. 5: CT scan in a patient with major pelvic trauma. This trauma patient suffers from multiple coexistent pelvic organs injuries including: open book injury (There is diastasis of the symphysis pubis and associated diastasis of the sacro-iliac joints - green arrow), rectal perforation (note the presence of free intraperitoneal bubbles air (white arrow) and the pelvic floor muscles' hematoma (right - bottom image) which is an indirect sign of coexisting rectal injury) and extraperitoneal urinary bladder rupture (red arrow demonstrates the accumulation of contrast material in extraperitoneal space extending into the rectus abdominis muscle).

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Fig. 6: 28 year-old man who suffered blunt abdominal trauma. CT scan shows high-density fluid representing blood (long arrow) within the superior portion of the greater omentum near the esophagogastric junction surrounded by omental fat (curved arrow). Note the free intraperitoneal blood around the liver and spleen due to coexistent mesenteric rupture.

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Fig. 7: Same patient - 28 year-old man who suffered blunt abdominal trauma. CT scan shows the greater omentum hematoma extending inferiorly (long arrow) surrounded by omental fat (curved arrow). Note that there is also a large acute hematoma in the lesser sac between the stomach and the pancreas (light blue arrow) and free intraperitoneal fluid around the liver and the spleen.

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**Fig. 8:** Vaginal and extraperitoneal bladder rupture: CT cystogram demonstrates contrast material in the perivesical and perirectal extraperitoneal spaces (light blue arrows). The extravasated contrast material demonstrates the typical "molar tooth" appearance. Note the inhomogeneous enlargement of the vagina due to an hematoma (white arrow).

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Conclusion

CT is the method of choice in defining pathology involving hollow organs' injury. It's important for radiologists to be familiar with the spectrum of imaging findings, as early diagnosis is critical to decrease patient morbidity and mortality.
References


