Diagnosis of bowel and mesenteric blunt trauma with multidetector CT

Y.-B. SHI, J.-M. HAO, C.-N. HU, L.-N. DOU

Department of Diagnostic Imaging, Xuzhou Central Hospital, Xuzhou, China

Abstract. – OBJECTIVE: To assess the examination methods, the multidetector CT (MD-CT), and findings of bowel and mesenteric injuries in blunt trauma and the evaluation for clinical management.

PATIENTS AND METHODS: Retrospectively analysis examination methods, image reformation, the sensitivity and specificity of variant appearance in MDCT of 43 cases of bowel and mesenteric injuries which were conformed by operation.

RESULTS: Contrast enhancement thin CT with multi-planner reconstruction MPR can improve the sensitivity of bowel and mesenteric injuries. Appearance of bowel and mesenteric injuries in MDCT included below: patchy or focal bowel wall thickening in 67.4%, intraperitoneal free air in 25.6%, mesenteric infiltration in 90.7%, and intraperitoneal fluid in 81.4%. Bowel wall discontinuity and intraperitoneal free air are specific to bowel injuries, whereas asymmetric bowel wall thickening, irregular enhancement of bowel wall, blurred serous membrane, and fluid of intestinal loop are strongly suggestive to bowel and mesenteric injuries.

CONCLUSIONS: Contrast enhancement thin CT with MPR can help improve to show direct and indirect sigh of bowel and mesenteric injuries with higher sensitivity and specificity.

Key Words:
- Intestines, Injuries, Trauma, Tomography, X-ray computed.

Introduction

Blunt bowel and mesentery injuries don’t have specific clinical history and injury location like penetrating injury. Most of the blunt injury is closed injury with a frequent companion of bowel and abdominal trauma. With the uncertain clinical history and covered symptom and signs, the secondary injury is more likely to be misdiagnosed and causes grave consequences. All the available diagnostic modalities – say, X-ray, ultrasound, diagnostic peritoneal lavage aspiration – have limitations. Although the diagnostic value of CT for blunt bowel and mesentery injuries was reported 30 years ago, CT scan has not been widely used for its poor sensitivity. Nowadays, with its improved properties and enhanced sensitivity, especially in z-axis coverage and temporal resolution, spinal CT has made a great contribution to diagnose blunt bowel and mesentery injuries. Forty-three cases’ CT findings considered diagnostic of bowel and mesentery injuries were detected retrospectively. Here’s the report.

Patients and Methods

Clinical Data

Between June 2007 and December 2013, 43 patients with bowel and/or mesentery injuries (27 men and 16 women), with an average age of 53 years (range 8-81 years), are included in our study. Thirty minutes to 18 h after admission, 39 patients complained of abdominal injury and pain, 3 of uncertain abdominal injury and pain while 1 case showed no abdominal injury but neck and head pain.

The injury resulted from car accident (31), falling injury (8), work-shop crushing injury (2), and violence injury (2). All cases were confirmed by surgery and the surgery was performed within 2-22 h after admission.

Methods

Eighteen patients were scanned by Philips Brilliance 16 CT, 14 cases by Philips Brilliance 64 CT, 7 cases by GE Discovery CT750HD, and 4 cases by Toshiba Aquilion ONE. Thirty-one patients underwent direct CT scan, while 12 others underwent plain and enhanced scan, of which 7 enhancement happened in 4-6 h. All cases don’t have oral contrast. The parameters of the scan images were slice thickness of 3-5 mm, thin slice
of 0.625-1.5 mm in the coronal reconstruction, equivalent to lung window, soft tissue window, and simple wide window images, respectively.

Image Analysis

Two experienced radiologists (both have worked for more than 9 years) were asked to read 36 CT scan and 9 scan images and came to a conclusion after discussion. The records included the location of the thickened bowel wall, the symmetry, the integrity, the density, the enhancement, the density and morphogenesis of the mesentery, the enhancement vesicular, the location of the intraperitoneal air, the location, morphogenesis, density (low density ≤ 30 HU, high density ≥ 50 HU) and quantity (few modest, mass) of the ascites, the organs, and structures injury.

Results

Of all 43 patients, 31 cases showed bowel and mesenteric trauma, 6 cases duodenum injury, 3 cases colon injury, 2 cases simple jejunum injury, and 1 case simple mesentery injury. The CT findings included: 67.4% (n = 29) patients presented with signs or symptoms suggestive of segmental or partial bowel wall thickening. Overall, 12 reported rupture in 15 cases of asymmetry thickening, 11 had thorough rupture in all discontinuous bowel wall (Figures 1 to 3), 6 had rupture in 9 cases of asymmetry bowel wall enhancement and incomplete serous surface and another 3 had complete rupture. Complications were seen with the following frequency among 7 cases of symmetry bowel wall enhancement: perforation in 1, swollen in 6, mesenteric injury in 2, operation because of ischemia in 2, no bowel rupture explored during spleen operation in 2. As many as 25.6% (n = 11) cases showed extraluminal free air (Figure 4) and complete bowel-wall rupture. The signs of gastrointestinal perforation included: air bar under the diaphragm (6), mesenteric air collection (5), bubble between the intestinal (4) (Figure 3), and bubble around the duodenum (4). What’s more, 90.7% of patients (n = 39) showed high density of mesentery. Five cases showed homogeneous, patchy, ground glass opacity high density (Figure 5). The 27 cases of inhomogeneous high density tend to be mesentery edema and hematoma (Figure 6). High density (>50 HU, n = 6) cases are mesentery hematoma. Two cases showed irregular vascular thickening in enhanced scan are vascular injury. Apart from that, 13 cases of effusion surrounding liver, spleen or colon, 7 bowel and mesentery injury, 33 polygonal effusions between mesentery in all 35 cases (81.4%) diagnosed of ascites. Accompanied injuries include splenic rupture in 8 cases, 5 cases of liver injury, 4 cases of renal injury, 1 case of pancreatic injury, pelvic fracture in 2 cases, 3 cases of rib fractures and/or pulmonary contusion, right scapula fractures in 1 case and 5 cases of craniocerebral injury.

Comparison of different imaging position to show signs of intestinal wall discontinuity: 5-mm layer thick plain transverse CT scanning in found

![Figure 1. Irregular thickening and interruption of the jejunal wall on the right side, seroperitoneum.](image1)

![Figure 2. Irregular thickening and interruption of the jejunal wall on the right side, infiltration of fat.](image2)
Diagnosis of bowel and mesenteric blunt trauma with multidetector CT

2 cases of suspicious intestinal wall discontinuity and 2-mm thin slice scanning 3 cases with 5 of suspicious cases, enhanced thin slice transverse scan in 9, enhanced thin slice coronal scan in 8, and enhanced thin slice in both transverse and coronal position scan in 11.

Discussion

Acute bowel and mesentery injury has different clinical guide compared with abdominal parenchymatous organ injury. Nowadays, abdominal blunt injury is more likely to take non-operative measures when there’s no active bleeding. Even active bleeding is found through CT scan, it is recommended to applying intervention al therapy to stop the bleeding, in order to save the organ function to a maximum extent[7]. For stable vital signs patients, diagnostic puncture peritoneal lavage or ultrasonic detection of seroperitoneum cannot decide whether they need to laparotomy or not. Bowel and mesenteric injury need timely operation treatment. Delayed diagnosis and treatment may result in abdominal infection, intestinal necrosis and bleeding, which tend to cause serious complications and even death. Data show[8] that duodenal perforation operated in 24h after injury, the mortality was 5%, but delaying treatment causes higher mortality. So when it comes to blunt abdominal trauma, timely diagnosis of intestinal and mesenteric injury is crucial. CT diagnosis for intestinal and mesenteric injury was reported 30 years ago. But it’s been not widely used for diagnosing intestinal and mesenteric injury for the limited CT properties[5,9]. With the improvement of CT technology in recent years, the accuracy has been significantly improved of diagnosis of intestinal and mesenteric injury. Campillo et al[10] reported that the diagnostic accuracy of CT was 79.7%, and our study shows 93% (40/43) accuracy. CT scan and image post-processing is crucial for diagnosis of bowel and mesenteric injury.

Figure 3. Irregular thickening and interruption of the jejunal wall on the left side, effusions around, pneumatosis intestinalis.

Figure 4. CT scan through upper abdomen shows retroperitoneal gas with lung window.

Figure 5. Ground glass opacity high density on the left mesentery, irregular thickening of blood vessels.
Methods

CT scan is recognized as one of the most effective ways to detect bowel blunt injury. Here are some important notes: (1) There’s a difference between abdominal fat and intestinal wall density. So we choose TLC-scanning focusing on the spatial resolution in order to display the structure of the intestinal wall and mesenteric vessels. (2) MPR scan is important for hollow organs. Scanning in a coronal plane has blind spots for displaying the intestinal wall injury, while it can display related injury features more sensitively in a sagittal position. (3) Plain CT cannot display the intestinal wall injury unless the rupture was severe. On the other hand, enhanced CT scan can do a better job showing the complete or partial rupture of intestinal wall, minimal inter-loops fluid collection, bubble between intestinal wall and abnormal changes of intestinal wall and mesenteric vasculature. Portal venous scanning is indispensable. Five-minute delayed scanning time is also recommended for detecting solid or cavity organ and mesenteric hemorrhage. (4) Multiple-window scanning. Only in a lung window, can CT scan display of free gas between the intestinal. Edema of mesenteric fat, which is a sensitive sign for showing bowel and mesentery injury, can be showed only in a window where all fat, air and soft tissue can be detected. And so does irregular enhancement of bowel wall in a narrow window. For example, faint or zero enhancement means full bowel-wall rupture in which condition surgery is needed. While over enhancement equals to hyperemia of intestinal wall, in this case, patients were observed only. (5) It’s still controversial whether patients should take oral contrast agent before the examination. We believe that it’s not necessary to do so because using oral contrast agent is influenced by the disease severity. On the other hand, it will have bad effects on intestinal wall injury images (e.g. intestinal effusion, bowel-wall thickening, etc.). Oral contrast extravasation is specific signs of bowel wall rupture, but it has a low sensitivity. It is reported that its sensitivity is less than 12%. Patients suffered complete intestinal wall injury even without hiatus will need operation treatment. The direct and indirect signs of bowel-wall injury may be accurately diagnosed by enhanced CT and MPR examination. So oral contrast will only be needed when perforation is suspected in stable condition.

CT Findings

Bowel Wall Discontinuity

The intestinal wall disruption is direct signs of bowel-wall rupture. Plain CT scan will show intestinal wall irregularities with surrounding increased fat fuzzy density or effusion when the big rupture happened. Interrupted ring-enhancement of bowel-wall in enhanced CT scan is a unique sign of rupture. But its sensitivity is as low as 7%. The sensitivity in our research is 23%, which is higher than that. Here are the reasons: (1) the differences in case group, (2) thin-section contrast enhancement scan and MPR is important.

Segmental bowel wall thickening and abnormal enhancement are also the direct signs of intestinal wall injury. The intestinal wall thickness of more than 3 mm, colon of more than 5 mm can come to a diagnosis of thickening. But it is not a precise diagnostic standard. On the one hand, there still exists difference among individuals. On the other hand, contraction and expansion of state have big influence on the thickness of the bowel wall. We prefer to judge the status of the wall based on its own thickness. Rupture cannot be diagnosed for when homogeneous ring proliferation and enhancement or obvious enhancement than adjacent bowel wall or muscle are detected. It could be some congestion and edema caused by the injury and required observation only. If unevenly thickness, incomplete serosa and heterogeneous or weak enhancement happened, intestinal wall injury or rupture should be strongly suggested and exploratory laparotomy is recommended. High density (>50 HU) thickening of
intestinal wall is often the symbol of hematoma. Still some hematomas show equal or lower density to the bowel wall. But on enhancement after enhanced scan is indication, Segmental bowel wall thickening and/or intestinal cavity effusion means intestinal wall damage but not rupture. Conservative treatment is highly recommended when there’s no severe mesentery injury. Bowel wall thickening is not a specific sign. But it needs to exclude thickening caused by non-traumatic reasons such as liver cirrhosis, heart failure and infection. However, it’s a sensitive sign for patients with trauma history. So diagnosis is not difficult if inspection method and clinical history were properly used. It is reported that bowel wall thickening in intestinal and mesenteric injury accounted for 55-75%4,14-15 and it accounted for 67.4% (29/43) in our study.

**Intraperitoneal Air**

Free intraperitoneal air is a high-specific sign of a gastrointestinal perforation. It’s easier to find free intraperitoneal gas in patients with gastric and colonic perforation, but because of no gas free in the small intestine in normal condition, free gas is not easy to be found when rupture happened. Prevalence of intraperitoneal gas is 20%4 as reported and 23% (10/43) in our study. Even when there’s free gas in intestine perforation, It tends to be little bubble. In this case, thin layer and lung window image is more useful. The free air can locate around the intestinal wall or perforation, or under diaphragm. The former one values much in diagnosis, whereas air under diaphragm should exclude pneumoperitoneum caused by diagnostic puncture, bladder rupture, pneumothorax, or postpull pneumothorax effusion (PPE).

**Mesentery**

The mesentery is rich in fat and blood vessels. So injury or chemical stimulation could induce mesenteric edema and bleeding. The CT mainly reflected patchy, ground-glass opacity, edge-unclear or stripy high density. It’s reported9 that mesenteric edema is very common in mesenteric injury. The signs of mesenteric hematoma are clear or obscure margin high density, no enhancement after injection of contrast agent. Mesenteric edema or hemorrhage with no bowel wall changes doesn’t mean bowel wall injury. So surgery is not necessary. Mesenteric vascular with beaded performance or interruption after injection of contrast agent means mesenteric vascular damage. Abnormal morphology of intestinal wall or abnormal enhancement is the operation indications for treatment. Sometimes the bowel wall shows no abnormalities in the first examination, but CT reexamination showed bowel wall edema and thickening, low perfusion or no enhancement. In this case, it belongs to secondary damage of bowel and observation should be terminated. Thirteen cases of mesenteric hematoma or vascular beaded/interrupt change in our research, 5 of them were confirmed as mesenteric vascular injury in surgery complicated with 7 cases of intestinal ischemia injury and cases of intestinal ischemia.

**Intraperitoneal and Inter-loops Fluid Collection**

Ascites is a common indirect signs of trauma of abdominal organ injury, especially the effusion surrounding parenchyma organ. One should watch out for bowel and mesentery injury when there’s no evidence for abdominal parenchyma organ injury. Abdominal parenchymatous organ injury usually adopts conservative treatment as long as there’s no active bleeding. But when massive hematocoele caused by bowel and mesentery injury existed, surgery is non-substitutable. Fluid collection, especially in multilateral shape, highly indicates bowel or mesentery injury but not parenchyma organ trauma. This sign is not very specific, but it is still sensitive signs secondary to edema of mesenteric fat and assists with locating the injury. As many as 76.7% (33/43) of the cases in our group have this indication.

**Conclusions**

When it comes to blunt abdominal intestinal and mesenteric trauma, MSCT and MPR image technique is the best radiological method to show direct and indirect signs of the injury with a high sensitivity and specificity and is helpful for clinical diagnosis and treatment.

**Conflict of Interest**

The Authors declare that they have no conflict of interests.

**References**


