Delayed Perforation of the Sigmoid Colon Due to A Seat Belt Injury

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ABSTRACT

Delayed small bowel perforation is uncommon after blunt abdominal trauma, including trauma caused by a seat belt. Delayed perforation of the colon is even rarer. A 21-year-old man suffered from multiple facial, thoracic, and abdominal ecchymoses after a car accident. Contrast-enhanced computed tomography (CT) of his brain, chest, and abdomen was performed at another hospital, but did not reveal any internal bleeding or hollow organ perforation. The patient was then transferred to our hospital. Initially, no special complaint was noted. However, the sudden onset of acute abdominal pain occurred 2 days later. CT revealed diffuse wall thickening of the ileum and sigmoid colon. Pockets of intraperitoneal air were identified, especially around the distal ileum and sigmoid colon. Hollow organ perforation at 1 of these 2 locations was suspected. Emergent laparotomy revealed avulsion of the sigmoid mesentery and perforation of the sigmoid colon. This incident should be kept in mind when deciding on a differential diagnosis for a patient suffering from acute abdomen days or weeks after blunt abdominal trauma.

Blunt abdominal trauma is a common cause of morbidity and mortality among patients suffering from multi-organ injuries. Clinical history and physical examination of patients with blunt abdominal trauma may be misleading, and could lead to delayed diagnosis and increased mortality [1-6]. Motor vehicle accidents are the leading cause of such injuries [1]. Bowel injuries occur in 3-18% of cases with blunt abdominal trauma, with the colon being less commonly involved [5-7]. The use of seat belts decreases mortality due to head injuries [8]; however, the incidence of injuries to the small bowel loop, colon, and lumbar spine increases due to the impact in the plane of the seat belt, and these are collectively termed as seat belt syndrome [8-13]. Seat belt sign refers to linear ecchymosis of the abdominal wall, which is associated with an increased risk of intestinal injury. Delayed perforation or fistula formation in the small bowel and colon may occur from 2 days to 2 months after the incident, and these increase sepsis and mortality [14-17]. This case report discusses the mechanism of seat belt injury, CT findings associated with delayed perforation of the colon, and other diagnostic examinations that can be used for patients who have suffered blunt abdominal trauma.

CASE REPORT

A 21-year-old man suffered from multiple facial, thoracic, and abdominal ecchymoses and bruising after a motor vehicle accident that occurred early in the morning. Initial loss of consciousness was noted. The patient was sent to a local hospital for resuscitation. Contrast-enhanced computed tomography (CT) scan of his brain, chest, and abdomen showed a fracture of the right medial third clavicle, but did not reveal any internal bleeding in the
intracranial, intrathoracic, or intraabdominal regions or the pneumoperitoneum. After resuscitation, he was transferred to our emergency department (3 hours later) and admitted. His body temperature was 38.2°C. Blood analysis was as follows: white blood cell (WBC) count = 26700/µl (normal range=3900-10600/µl); creatine kinase (CK) = 1440 U/L (normal range = 55-170 U/L); CK-MB = 25 U/L (normal < 16 U/L); and troponin I = 0.34 µg/L (normal < 0.11 µg/L). Urinalysis detected presence of occult blood with 2+ value. Transthoracic echocardiography revealed trivial aortic and mitral regurgitation and mild pulmonary regurgitation. Electrocardiogram showed normal sinus rhythm. On

**Figure 1.** Contrast-enhanced computed tomography (CT) reveals pockets of air in the fissure of the falciform ligament (a), anterior to the liver and in the liver hilar region (b), and larger pockets of air accumulation (thin arrows in c and d) contiguous to the distal ileum (long thick arrow in d) and sigmoid colon (short thick arrow in d), both of which have thickened walls. At the level of the larger pocket of air accumulation (c), a transverse band of mildly hyperdense infiltration is seen in the subcutaneous region of the anterior abdominal wall corresponding to the skin ecchymosis caused by the seat belt lapstrap. Note the normal hypodense subcutaneous fat in the bilateral buttocks (c). Ascites is seen inferior to the sigmoid colon and above the urine-filled urinary bladder (d).
physical examination, a transverse band of skin ecchymosis was found on the lower abdomen that corresponded to the lapstrap of the seat belt. A head injury with brain concussion and multiple lacerations and abrasion wounds on the face, chest, and abdomen were diagnosed. The patient’s abdomen was soft, and his vital signs were normal. A figure-8 sling was used for fixation of the clavicular fracture, and suturing of the bilateral eyelid lacerations was performed. The patient’s body temperature was 36.6°C, and he was discharged 2 days later.

However, he returned to our emergency department 6 hours after discharge with acute abdomen (left lower abdomen) and cold sweating. Blood analysis revealed a WBC count of 11870/μl. Therefore, an abdominal CT was immediately performed using a 64-detector row multidetector CT (MDCT, Brilliance CT 64-channel by Philips Medical Systems, Haifa, Israel) with intravenous contrast administration (Fig. 1). Diffuse wall thickening of the ileum and sigmoid colon was found, and extraluminal fluid was noted in the peritoneal cavity (ascites). Pockets of intraperitoneal air were seen in the fissure of the falciform ligament anterior to the liver and in a non-dependent site of the peritoneal cavity. A larger accumulation of air was noted in the pelvic cavity contiguous to the distal ileum (wall thickness, 0.7 cm) and the sigmoid colon (wall thickness, 0.5 cm), both of which had thickened walls. An associated transverse and linear subcutaneous infiltration was seen in the anterior abdominal wall at the level of the largest pocket of air accumulation, and corresponded to the skin ecchymosis caused by the lapstrap of the seat belt (Fig. 1c).

Hollow organ perforation with the perforation site at 1 of the aforementioned bowel loops was suspected. Emergent laparotomy revealed marked fecal contamination at the mesenteric side of the middle portion of the sigmoid colon and 200 cc turbid ascites. An avulsion of the 25-cm long mesentery of the sigmoid colon and a 2 cm perforation hole at the mesenteric side of the middle portion of the sigmoid colon were identified. High anterior resection and end-to-end anastomosis were performed. The pathological report showed a 1.5 × 2 cm perforation hole at the sigmoid colon with dense transmural infiltration of inflammatory cells (Fig. 2). Mucosal necrosis, congestion and hemorrhage in the colonic mucosa, marked congestion in the vessels of the serosa, and infiltration of neutrophils in the serosal soft tissue were also found. The post operative course was uneventful during 9 days of hospitalization.

DISCUSSION

Blunt abdominal trauma is a common cause of morbidity and mortality among patients suffering from multiple traumatic injuries; these are frequently due to high velocity, compression, and deceleration mechanisms [1]. Motor vehicle accidents are the leading cause of such injuries. The clinical history and physical examination of a patient with blunt abdominal trauma may be misleading, causing delayed diagnosis and increased mortality [1-6]. Early diagnosis of bowel perforation is often difficult, and peritonitis may not be apparent for several hours after the

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**Figure 2.** On microscopic examination with hematoxylin/eosin stain, a. the colon shows perforation with dense transmural infiltration of inflammatory cells (×40), b. the colonic mucosa is characterized by mucosal necrosis, congestion, and hemorrhage (×200), and c. the vessels of the serosa have marked congestion accompanied by the infiltration of neutrophils in the serosal soft tissue (×100).
Delayed perforation due to a seat belt injury

A delay of more than 24 hours in the diagnosis of a small bowel perforation has been shown to increase the mortality rate from 5% to 65% [3]. The classic triad of rigidity, decreased bowel sounds, and abdominal tenderness occurs only in one-third of patients with small bowel perforation [3, 4]. Mesenteric injuries are about 3 times more frequent than bowel perforations. Bowel injuries occur in 3-18% of cases with blunt abdominal trauma, with the colon being less commonly involved [5-7]. It may be due to the fact that less force is needed to injure the small bowel than that required to injure the colon [7]. The most common type of injury is perforation of the small bowel loop and serosal tears of the colon. An isolated bowel injury is rare (1-2%) [6].

The use of seat belts decreases the mortality rate by 30-60%, mainly by reducing the number of fatal head and chest injuries [8, 9]. However, the incidence of injuries to the small bowel loop, mesentery, colon, and lumbar spine increases due to the impact in the plane of the seat belt, which is collectively termed as seat belt syndrome [8-13]. This syndrome occurs when seat belts are incorrectly positioned so that instead of resting on the superior anterior iliac crest the belt is located across the abdominal wall at the time of the traffic accident [9]. As a result, a linear ecchymosis appears on the abdominal wall, and this is known as the seat belt sign. This sign is associated with an increased incidence of intestinal injury.

Three mechanisms are proposed to explain the type of injury to the bowel and its mesentery caused by blunt abdominal trauma [10, 11]. First, a seat belt may crush the bowel. This leads to lacerations of the bowel wall and mesentery, mesenteric hematoma, bowel transection, focal devascularization, and full-thickness contusions. The regions associated with the contusion may become devitalized and delayed perforation may subsequently occur with ischemic necrosis shown by histopathology. Devascularization is more common in the small bowel than in colon [11]. Occasionally, scarring may occur at sites of ischemia and contusion, and can cause very late stenosis and obstruction of the bowel. This may have happened in our case because we observed avulsion of the mesentery of the sigmoid colon and a transmural perforation at the mesenteric side of the sigmoid colon along with mucosal necrosis and hemorrhage. The mucosal necrosis implies that the perforation was not acute.

Second, rapid deceleration may cause prominent shearing forces between the relatively fixed and mobile segments of the bowel loop. The fixed parts of the bowel include the ligament of Treitz, the ileocecal junction, and each end of the sigmoid colon. The resulting tears lead to lacerations of the bowel wall and mesenteric vessels leading to hemorrhage and infarction. Third, wall tension increases when the direct pressure on the bowel increases. Bursting injuries occur when the intraluminal pressure exceeds the tensile strength of the bowel wall, causing a full-thickness perforation, especially in the small bowel loop. In the colon, the extensive wall tension may cause more common linear seromuscular tears.

Several diagnostic tools may help in the diagnosis of bowel and mesenteric injuries after blunt abdominal trauma [1, 3, 4, 6, 10, 11]. Initial radiography is not as sensitive to air (detection rate of 8.3%) as compared to CT (detection rate of 58.3%) [4]. In order to detect free intraperitoneal air, plain radiographs of the upright or left decubitus are taken after the patient has remained in position for at least 10 minutes [6]. However, the absence of pneumoperitoneum does not rule out an intestinal perforation [6-7].

Small bowel series can be useful for diagnosing a duodenal perforation [4]. However, they are impractical because the procedure is time consuming and the imaging quality is suboptimal with increasing dilution of the water-soluble contrast medium when the perforation site is at the distal portion of the bowel loop.

For hemodynamically unstable patients with an abdominal injury, immediate laparotomy or diagnostic peritoneal lavage (DPL) should be performed [3, 10]. Although the sensitivity for the detection of visceral injuries is high (> 90%), DPL is an invasive procedure and is unable to detect retroperitoneal organ injuries. It also cannot differentiate between injuries requiring surgery and those that do not [3, 10]. Therefore, DPL is not performed in some hospitals [4, 11].

Focused abdominal sonography for trauma (FAST) is recommended for the initial examination of injured patients [10, 11] because it is a rapid, inexpensive, and noninvasive procedure that has been shown to be as accurate as DPL and CT in the detection of hemoperitoneum in patients with abdominal trauma. Sonography of the pericardium, bilateral subphrenic spaces, Morison pouch, perisplenic space, and pelvic cavity is performed with the patient in a supine position. The drawback is that it is operator-dependent and not specific for a type of organ injury.

Diagnostic laparoscopy has been shown to have high sensitivity (94-96%) and specificity (98-100%) [6, 10], and it is an efficient diagnostic and therapeutic tool for abdominal trauma. However, its true value had to be verified in larger case series.

CT is currently considered the modality of choice for the diagnosis of bowel perforation because of its ability to detect extraluminal air and extravasated oral contrast medium [1-7, 10, 18, 19]. Any abnormal finding on abdominal CT should be assumed to be due to the traumatic injury and not due to any preexisting condition [7]. The specific CT findings for bowel perforation are extraluminal oral contrast extravasation and discontinuity of the bowel wall [2]. CT findings suggestive of bowel injury include pneumoperitoneum, pockets of air contiguous to the injured bowel, bowel wall thickening (> 4 mm), bowel wall hematoma, and intraperitoneal fluid of unknown cause.

CT is able to detect air pockets < 1 mm³ [18]. However,
it has a fairly low sensitivity (20-67%) and specificity (11-39%) for the detection of pneumoperitoneum in bowel perforation. The absence of pneumoperitoneum does not rule out bowel perforation [6, 7]. In a study performed by Kim et al. [5], extraluminal air was found in < 60% of cases with proven bowel perforation. It may be due to the fact that the small bowel does not originally contain much air, the bowel loops and mesentery may be closely wrapped around each other, the omentum may cover the perforation site, or a bowel spasm may interrupt the passage of air [4]. However, the chance of detecting extraluminal air increases over time [4, 5]. Therefore, follow-up CT is recommended, particularly after 8 hours, even if no extraluminal air is detected on the initial CT performed shortly after the blunt abdominal injury [4]. Also, the performance of CT to detect pneumoperitoneum and extravasation of oral contrast medium should occur at least 2 hours after the trauma in order to prevent false-negative results [19]. The recognition of even a tiny pocket of extraluminal air may be missed; the detection error rate is reduced by intensive education of the CT interpreter [18]. Pneumomediastinum or pneumothorax dissecting into the peritoneal cavity, bladder rupture, prior DPL, and patients on ventilators (barotrauma) contribute to the fairly low specificity of CT detection of intraperitoneal air after trauma [3, 5, 7, 18].

CT is also not very useful in detecting the site of colonic perforation (detection rate 20%) [5]. This may be misdiagnosed as a small bowel perforation due to inflammatory changes in the adjacent small bowel (i.e., wall thickening of the small bowel) and mesentery. Our case had CT findings similar to a preoperative diagnosis of the ileal or sigmoid colonic perforation.

In blunt abdominal trauma, focal wall thickening (> 4 mm thickness) of the small bowel loop seen on CT may be due to an intramural hematoma or a small tear causing the wall to become hyperdense and assume a concentric or eccentric appearance [1, 3]. If the wall is thickened posteriorly but appears normal anteriorly, it is most likely normal, with the posterior appearance due to dependent bowel content [7]. Intense enhancement of the bowel wall combined with bowel wall thickening and free intraperitoneal fluid is highly suggestive of bowel perforation and peritonitis [3].

Low or high density ascites and mesenteric fat obliteration may be seen after blunt abdominal trauma with or without bowel perforation [3-5] if other disease entities such as solid organ laceration, liver cirrhosis, and acute pancreatitis are excluded. The hypodense ascites is due to the bowel contents, and the blood causes hyperdense ascites. A mesenteric hematoma may be due to bowel perforation or laceration of mesenteric vessels. Mesenteric fat obliteration can help localize the site of perforation because the hemorrhagic and inflammatory changes are most obvious around the site of perforation.

Seat belt injury can cause delayed perforation of the small bowel loop and colon; delays can range from 2 days to 2 months [14-16] and include delayed fistula formation in the sigmoid colon [17]. The perforation that occurred at the time of the injury is walled off by the surrounding omentum and mesentery, and the rupture of the resulting abscess causes the sudden onset of symptoms days later [15]. The delayed perforation may also be due to the sequence of mesenteric or intramural contusions or bowel ischemia that occur following mesenteric injury at the time of impact; these are followed by stricture formation due to the reduced elasticity of the injured bowel loop and later perforation of the bowel loop due to increased intraluminal pressure [16].

In conclusion, intestinal perforation is a diagnostic challenge after blunt abdominal trauma, especially after seat belt injury; a delay in diagnosis increases morbidity and mortality. Delayed perforation of the colon is rare after seat belt injury. The seat belt sign hints at an increased likelihood of intestinal injury. A high index of suspicion should be kept in mind and follow-up imaging examinations (e.g., CT) should be performed to prevent delayed perforation of the bowel loop. The incidence of delayed colonic perforation should be considered when attempting a differential diagnosis for a patient suffering from acute abdomen days or weeks after a blunt abdominal trauma. CT is a good modality for detecting bowel and mesenteric injuries and prompts emergent surgical exploration.

REFERENCES

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