

Original Article

Surgical experience of delayed intestinal necrosis following blunt abdominal trauma: 19 consecutive cases in 10 years

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Abstract: To summarize characteristics of delayed intestinal necrosis following blunt abdominal trauma seen in the past 10 years, to improve diagnostic accuracy and curative effects. We retrospectively analyzed clinical data from patients with delayed intestinal necrosis following blunt abdominal trauma, who were admitted to Shanghai Changhai Hospital affiliated with Second Military Medical University, China, between January 2004 and December 2014. All cases of intestinal necrosis were diagnosed surgically and pathologically. Clinical records from 19 delayed intestinal necrosis cases (1.82%) out of a total of 1043 patients with blunt abdominal trauma were reviewed. Injuries comprised 11 jejunum, 10 ileum and 5 colon injuries and the average length of intestinal injuries was 26.47 ± 34.26 cm. Eight patients had grade I or II surgical complications, and three patients developed abdominal bleeding and anastomotic leakage, which were treated by conservative or surgical management. Three patients developed severe intraperitoneal sepsis and died within one month after surgery. All patients with severe blunt abdominal trauma should be followed closely with repeated physical examinations to detect any signs of peritonitis. Tests for plasma fatty acid binding protein (FABP) levels, serial abdominal CT scans and timely exploratory laparotomy should be performed if necessary.

Keywords: Intestinal necrosis, abdominal trauma, treatment

Introduction

Trauma is a leading cause of death and disability in developing countries and it is the most common cause of death in people under the age of 45 years [1]. The World Health Organization estimates that, by 2020, trauma will be the worldwide leading cause of lost productive years. The abdomen is one of the most commonly injured areas, with abdominal trauma requiring surgery in about 25% of all cases, and trauma characterized as blunt trauma in 85% of cases [2]. Blunt abdominal trauma remains a challenging problem, causing significant morbidity and mortality despite improvements in diagnosis and clinical management. Delayed treatment of intestinal necrosis is a main concern after blunt abdominal trauma, with various symptom manifestations that

often leads to a faulty diagnosis and treatment plan. Here, we review our experience with cases of abdominal trauma over the past 10 years to better understand the clinical manifestations of abdominal trauma, the causes of delayed intestinal injuries following blunt abdominal trauma and the best methods for accurate and timely diagnosis to guide clinical management of delayed intestinal necrosis.

Material and methods

Patients

Written informed consent was obtained from patients for publication of their individual information and accompanying images in this manuscript. The consent form is held by the authors' institution and is available for review by the Editor-in-Chief.

Patients were eligible for inclusion in our review if they had delayed intestinal injuries that had not been diagnosed or surgically treated within 72 hours after blunt abdominal trauma. Patients with central nervous system diseases were excluded. All patients were treated at Shanghai Changhai Hospital between January 2004 and December 2014. The Shanghai Changhai Hospital is affiliated with Second Military Medical University, China, a tertiary care teaching hospital with more than 2,400 beds, which serves over 55,000 inpatients, 2,100,000 outpatients and 400,000 emergency cases each year. All data were collected retrospectively with appropriate consent from patients involved in the study.

Diagnosis

All patients with blunt abdominal trauma underwent careful physical examination, laboratory examination (including complete blood count, biochemical profile, plasma concentration of fatty acid binding protein (FABP) tests and urinalysis) and focused abdominal ultrasonography (US). Erect abdominal radiography and computed tomographic (CT) scans were performed if the diagnosis was not confirmed or if intestinal perforation was suspected. Diagnostic abdominal paracentesis or peritoneal lavage was performed if necessary.

Treatment

Patients with heteropathy fasted before laboratory tests during the observation period. Emergency surgery was performed if intestinal injuries or peritonitis was confirmed.

Results

Patients

Between January 2004 and December 2014, the clinical records of 19 patients with delayed intestinal necrosis (1.82%) out of a total of 1043 patients with blunt abdominal trauma were reviewed. These patients comprised 13 men and 6 women with a mean age of 52.89 ± 11.03 years (range, 33-74 years).

Mechanism of injury

The mechanisms of the blunt abdominal trauma included crush injuries in six patients (five

of whom were injured by structural collapse while one patient was injured in a stampede), vehicle accidents in six patients, high fall injuries in four patients (three patients fell from scaffolds at construction sites while one patient fell down a flight of stairs), impact injuries in three patients (two patients were struck in abdomen by blunt tools while working, and one patient was hit in the abdomen by a hammer during a fight).

Anatomic distribution of injuries

Injuries comprised 11 jejunum, 10 ileum and five colon injuries in the 19 patients and the average length of intestinal injuries was 26.47 ± 34.26 cm (range, 2-150 cm; 4 patients had only small intestinal or colon perforation). In our study, the largest amount of intestinal ischemic necrosis was over 150 cm (**Figure 1**).

Time between blunt abdominal trauma and confirmation diagnosis of intestinal injuries

All the patients were diagnosed with intestinal injuries more than 72 hours after blunt abdominal trauma. The average time to confirmed diagnosis of intestinal injuries and surgical treatment following blunt abdominal trauma was 161.89 ± 66.52 hours (range, 96-336 hours).

Clinical manifestation and physical examination

Mild to moderate abdominal pain was the first symptom in all patients, and abdominal distention was the most common clinical finding (in 19/19 patients), which increased with progression of injuries. The symptoms of peritonitis including tenderness, rigidity and fever in 11/19 patients immediately before surgery, and these symptoms were not present in any patients at the time of admission. Other digestive symptoms including nausea, vomiting, diarrhea and melena were only seen in less than half of patients (42.11%, 26.32%, 21.05% and 21.05%, respectively).

Diagnostic examinations

Plasma concentration of fatty acid binding protein (FABP) gradually increased in 14/19 patients, and the values varied greatly in different patients. White blood cell counts were

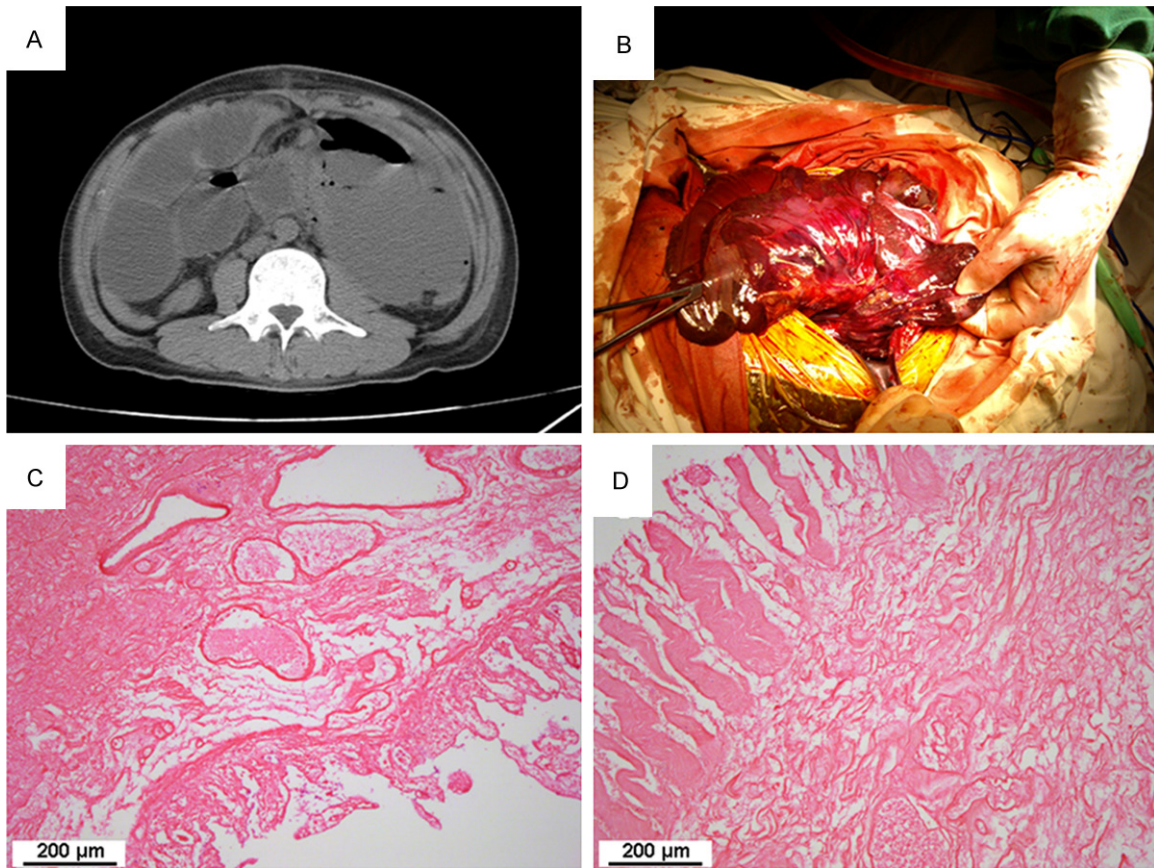


Figure 1. A 40-year-old male patient presented at our hospital after a vehicle accident and complained of abdominal pain during his first visit to the emergency department. The first abdominal computed tomography (CT) scan was performed four hours after blunt abdominal trauma, but there were no positive findings. The patient had heteropathy and was discharged after five days of observation; he had no fever and was tolerating a regular diet at the time of discharge. The patient returned to our hospital 12 days after discharge (17 days post-trauma), complaining of abdominal pain and severe distention with vomiting and symptoms of intestinal obstruction. A. CT scan before surgery showed signs of severe intestinal obstruction. B. During the operation, we found the range of intestinal ischemic necrosis reached over 150 cm. C, D. Large necrotic lesions along with macrophage infiltration were observed in the intestinal mucosa and collagen fiber hyperplasia was present on submucosal membrane. (×200 magnification).

found to increase during intestinal necrosis, but this was not a sensitive indicator in predicting intestinal necrosis and could be confounded by multiple associated injuries. Other laboratory tests were not helpful in prediction of intestinal necrosis. Diagnostic abdominal paracentesis or peritoneal lavage was performed in seven patients, and the results were positive for only two patients.

All patients underwent focused abdominal ultrasonography (US) at least two times (range, 2-5 times), and seroperitoneum was found in six patients; this was diagnosed as an alimentary tract injury in these patients. Erect abdominal plain radiographs were performed on 15 patients and only 2 (13.33%) were found to

have pneumoperitoneum. A total of nine patients underwent CT scans on the first hospital day but no abnormalities were found. Later CT scans were performed in 16 patients and 13 (81.25%) were found to have abdominal free gas, abdominal effusion, abdominal abscess or omentum edema caused by inflammation. Diagnostic laparoscopic exploration was performed in 2 patients, both of whom were found to have intestinal necrosis.

Surgical management

All the patients underwent emergency surgery when diagnosis of alimentary tract injuries or peritonitis was confirmed. The surgeries included resection of necrotic intestine, removal of

necrotic tissue and peritoneal lavage and drainage. Patients with intestinal injuries underwent primary anastomosis, and patients with colon injuries underwent ileostomy or colostomy.

Complications and mortality

An uncomplicated postoperative course was only experienced by 5 patients (26.32%). A total of 8 patients (42.11%) had grade I or II surgical complications post-operation (according to the Clavien-Dindo Classification of Surgical Complications) including incision infection, pleural/peritoneal effusion, pneumonia, catheter-related infection or stomal bleeding (accompanied by severe liver cirrhosis) and were treated by conservative management.

Abdominal bleeding occurred in one patient and was confirmed as a small mesenteric artery hemorrhage during a second surgery. Two patients developed anastomotic leakage; one patient's leakage was resolved by percutaneous drainage, but the other underwent a second operation to remove the former intestinal anastomosis, proximal intestinal colostomy and close the distal small intestine enterostomy after percutaneous drainage. One patient developed whole intestinal necrosis caused by superior mesenteric artery embolism after the first operation, and died of a severe fungal infection on the 17th day after excision of the whole small intestine in a second operation. Two patients developed severe sepsis and died within 72 hours after surgery.

Discussion

While perforating intestinal tract injuries are often associated with penetrating abdominal trauma, the incidence of intestinal injury was less than 1% in all blunt abdominal trauma patients. However, delayed intestinal necrosis often resulted in devastating complications. Since Samuel Annan reported the first case of intestinal injury secondary to blunt trauma in 1837, few publications on this subject exist in the literature and most of them are case reports [1-3]. We reviewed the clinical characteristics of delayed intestinal necrosis following blunt abdominal trauma over the past 10 years and aimed to improve the medical diagnostic accuracy and efficiency of treatments.

Some authors have argued that these injuries should be called "intestinal perforation with a

delayed diagnosis"; however, no direct injury mechanisms [4] could explain the patients in whom intestinal perforation occurred many days after blunt abdominal trauma. There are various pathophysiological mechanisms responsible for delayed intestinal injuries after blunt abdominal trauma. Gong et al. [5] suggested that intestinal necrosis diagnosed 12-22 days after abdominal trauma in three patients may have been strongly associated with mental stress from the trauma. Mesenteric injuries have been proposed as the most common cause of delayed intestinal necrosis after blunt abdominal trauma [3, 6]. Shilyansky et al. [7] reported that mesenteric injuries occurred at almost three times the rates of other intestinal injuries. Traumatic mesenteric injuries are potentially severe complications of blunt abdominal trauma, which could cause life threatening hemorrhage from disruption of mesenteric vessels or/and fatal peritonitis from intestinal ischemic necrosis. Moreover, some authors described stenotic segments of intestine adjacent to mesenteric tears, which could induce delayed intestinal necrosis. Chatzis et al. [8] proposed that an impaired blood supply that results in mucosa ischemic ulceration and healing by fibrosis or cicatricial stenosis may compromise blood flow to this intestinal segment. In our study, the largest range of intestinal ischemic necrosis was over 150 cm, which may be caused by mesenteric vessel injury or mesenteric hematoma after blunt abdominal trauma.

Delayed treatment of intestinal necrosis is a main concern in blunt abdominal trauma patients, because this type of injury remains difficult to diagnose in a timely manner [1, 2, 9]. In most cases, none or only subtle physical findings of intestinal injury could be detected during the initial clinical examinations, and the classic clinical trial of intestinal injuries-weakened bowel sounds, abdominal tenderness and rigidity-was absent in nearly two-thirds of patients [10]. Our research lends further support to these views and finds that abdominal distention is the most common finding at the onset of intestinal necrosis and should be noted with care during the observation period. Although diagnostic abdominal paracentesis and peritoneal lavage were valuable and effective in detecting hemorrhage after blunt abdominal trauma, both examinations were of relative-

ly limited use in patients with delayed intestinal necrosis [11]. Because intestinal seroperitoneum was difficult to identify by diagnostic abdominal paracentesis, the accuracy of peritoneal lavage also had low and false-positive lavage results, which may lead to nontherapeutic laparotomy rates of 6% to 25% and associated morbidity [12]. Therefore, we do not suggest performing diagnostic abdominal paracentesis or peritoneal lavage in patients in the absence of a definitively positive finding by ultrasound or CT examination.

The use of CT scans to diagnose intestinal injuries following blunt abdominal trauma still remains controversial. In previous studies, most authors have discouraged the use of CT scans to diagnose intestinal injuries because CT scans may not specifically recognize this kind of injury [13]. However, with progress in imaging techniques, CT scans have been shown to be the most sensitive and accurate method for detecting intestinal and mesenteric injuries caused by blunt abdominal trauma and they have been found to be useful in guiding surgical or conservative medical management [14]. An optimal CT technique is essential for the diagnosis of many subtle traumatic intestinal injuries. In our studies, the detection rate by eventual CT scans was higher than that in other examinations; we therefore recommend that when possible, CT scans should be used with intravenous contrast to improve yield and they should be performed repeatedly to improve diagnostic accuracy. According to our results, we suggest that FABP, which was released by epithelial cells of the intestinal mucosa into the circulation after mucosal damage, could serve as a specific marker of intestinal damage [15]. FABP could be deemed to be a routine test marker for patients with severe trauma, which would aid in early abdominal exploration and facilitate early diagnosis of intestinal necrosis after blunt abdominal trauma.

It is essential to be aware of delayed intestinal necrosis after blunt abdominal trauma and the limitations of current diagnostic techniques. Diagnostic challenges resulting in delayed surgical treatment can eventually increase morbidity and mortality. All patients with severe blunt abdominal trauma should be followed closely using repeated physical examinations,

plasma concentration of FABP tests and serial abdominal CT scans if necessary, to detect any signs of delayed intestinal necrosis.

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Disclosure of conflict of interest

None.

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References

- [1] Faria GR, Almeida AB, Moreira H, Barbosa E, Correia-da-Silva P and Costa-Maia J. Prognostic factors for traumatic bowel injuries: killing time. *World J Surg* 2012; 36: 807-812.
- [2] van der Vlies CH, Olthof DC, Gaakeer M, Ponsen KJ, van Delden OM and Goslings JC. Changing patterns in diagnostic strategies and the treatment of blunt injury to solid abdominal organs. *Int J Emerg Med* 2011; 4: 47.
- [3] Torba M, Gjata A, Buci S, Troci A and Subashi K. Delayed presentation of blunt duodenal injuries in children. Case report and review of literature. *G Chir* 2013; 34: 122-124.
- [4] Vertruyen M, Nardini J and Bruyns J. Isolated perforations of the small bowel from blunt abdominal trauma. Report of two cases and review of the literature. *Acta Chir Belg* 1995; 95: 76-80.
- [5] Gong JQ, Zhang GH, Tian FZ, Wang YH, Zhang L, Cao YK and Wang PH. Stress-induced intestinal necrosis resulting from severe trauma of an earthquake. *World J Gastroenterol* 2012; 18: 2127-2131.
- [6] Sharma OP, Oswanski MF and White PW. Injuries to the colon from blast effect of penetrating extra-peritoneal thoraco-abdominal trauma. *Injury* 2004; 35: 320-324.
- [7] Shilyansky J, Pearl RH, Kreller M, Sena LM and Babyn PS. Diagnosis and management of duo-

- denal injuries in children. *J Pediatr Surg* 1997; 32: 880-886.
- [8] Chatzis I, Katsourakis A, Noussios G, Chouridis P and Chatzitheoklitos E. Delayed small bowel obstruction after blunt abdominal trauma. A case report. *Acta Chir Belg* 2008; 108: 597-599.
- [9] Yusif-Zada K, Safarov R and Gafarov A. Isolated small bowel perforation following blunt abdominal trauma. *Ann Ital Chir* 2013; 84: 699-703.
- [10] Campillo-Soto A, Soria-Aledo V, Renedo-Villarroya A, Millan MJ, Flores-Pastor B, Girela-Baena E, de Andres-Garcia B, Carrillo-Alcaraz A, Martin-Lorenzo JG and Aguayo-Albasini JL. [Computerised tomography in the diagnosis of intestinal and mesenteric injuries in closed abdominal trauma]. *Cir Esp* 2009; 86: 13-16.
- [11] Al-Mudhaffar M and Hormbrey P. Abdominal trauma. *BMJ* 2014; 348: g1140.
- [12] Lee MJ, Sperry JL and Rosengart MR. Evaluating for acute mesenteric ischemia in critically ill patients: diagnostic peritoneal lavage is associated with reduced operative intervention and mortality. *J Trauma Acute Care Surg* 2014; 77: 441-447.
- [13] Weis JJ, Cunningham KE, Forsythe RM, Billiar TR, Peitzman AB and Sperry JL. The importance of empiric abdominal computed tomography after urgent laparotomy for trauma: do they reveal unexpected injuries? *Surgery* 2014; 156: 979-985.
- [14] Mehta N, Babu S and Venugopal K. An experience with blunt abdominal trauma: evaluation, management and outcome. *Clin Pract* 2014; 4: 599.
- [15] Relja B, Szermutzky M, Henrich D, Maier M, de Haan JJ, Lubbers T, Buurman WA and Marzi I. Intestinal-FABP and liver-FABP: Novel markers for severe abdominal injury. *Acad Emerg Med* 2010; 17: 729-735.