

# Blunt Intestinal Trauma

## A Modern-day Review

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During the 5-year period from January 1978 through December 1982, 196 patients with blunt trauma to the small bowel, colon, or mesentery were treated at the Maryland Institute for Emergency Medical Services Systems (MIEMSS) Shock Trauma Center. More than 80% of these patients were the victims of motor vehicle accidents and therefore commonly had multisystem injuries. Sixty of these patients suffered 83 major injuries in the form of perforation or mesenteric injury resulting in ischemic bowel. This group accounted for 6.9% of the 870 patients who had celiotomy for blunt trauma during this period. Several significant observations were made. All injuries, except one, were diagnosed by peritoneal lavage. Only two duodenal injuries were present. Perforations involving the jejunum and ileum were distributed throughout the entire length of the small bowel. Colon injuries comprised one-fourth of the major injuries, with most occurring in the ascending and sigmoid colon. There were 16 deaths, 6 of which occurred as a result of complications from the bowel injury.

**B**LUNT TRAUMA to the abdomen resulting in perforation or devascularization of the intestine has captured the intrigue of many surgeons through the years. The mystique associated with the relative infrequency, mechanism of injury, location, and difficulty in diagnosis of these lesions has been the theme of many reports. Geill, in 1899, reported an 11% incidence of major intestinal injury among his patients sustaining blunt abdominal injury.<sup>1</sup> This figure is consistent with the 5–15% reported in other series, making the intestine the third most commonly injured abdominal organ in blunt trauma.<sup>2–5</sup> In spite of this, most institutions have had a paucity of experience with these injuries. Indeed, in 1948, Bosworth calculated an incidence of only 1 of 10,000–20,000 admissions to the general surgery services of six major hospitals in New York City during a 10-year period.<sup>6</sup> Although more common today, these injuries are still seen relatively infrequently. Many theories have been introduced to explain why these injuries occur. Vance credits Moty with postulating the three

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most popular mechanisms<sup>7</sup>: (1) crush injury between the vertebrae and anterior abdominal wall; (2) sudden increase in the intraluminal pressure of the bowel; and (3) tangential tears at relatively fixed points along the bowel. Others think that factors such as age and degree of intoxication may encourage these injuries because of their influence on the musculature of the abdominal wall.<sup>8</sup> In 1935, Counseller and McCormack gave evidence to the “fixed point” theory when they reviewed the world literature on the subject.<sup>9</sup> They analyzed over 1000 cases and reported that the majority of small bowel injuries occurred in the proximal jejunum or distal ileum. The mortality was a terrifying 73%, and missed or delayed diagnosis was implicated as the major contributing factor. Poer called for increased awareness of these injuries and encouraged celiotomy based upon suspicion alone.<sup>10</sup> His series consisted mainly of isolated abdominal injuries. Today, most of these injuries occur as a result of motor vehicle accidents, and many of the patients have multisystem injuries. These polytrauma patients are more difficult to evaluate; bowel injuries are still missed despite improved diagnostic techniques. Intestinal injury probably has more lethal potential than any other abdominal injury if not diagnosed on initial evaluation. Experience gained from this review has been of assistance in the evaluation and management of subsequent patients. We hope that it will make others more conscious of these injuries and therefore permit more expedient diagnosis and treatment.

### Methods

During the 5-year period beginning January 1, 1978 and ending December 31, 1982, there were 6745 admissions to the MIEMSS Shock Trauma Center. The ma-

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majority of these patients were victims of high-speed motor vehicle accidents and, as a result, had multisystem injuries. The patients were categorized prospectively from year to year, with major emphasis on those sustaining blunt abdominal trauma (BAT). A summary of these 870 patients who underwent celiotomy for BAT has been published.<sup>11</sup> From this file, 196 patients were identified as having an injury to the small bowel, colon, or mesentery. The charts of these patients were reviewed and their injuries classified as being major or minor in nature. Major injuries were defined as: (1) transmural perforation or transection of the bowel; (2) mesenteric injury resulting in ischemic bowel which required resection; (3) contusions of the bowel wall with seromuscular damage requiring resection or exteriorization; or (4) injury to the root of the mesentery resulting in a tear of the superior mesenteric artery (SMA), superior mesenteric vein (SMV), or both. Minor injuries included serosal tears and mesenteric injuries not resulting in ischemic bowel. This report deals with 83 major injuries that were distributed among 60 patients. Information regarding age, sex, mode of injury, associated injuries, location of injury, treatment, and morbidity and mortality were abstracted and forms the basis of this review.

## Results

### Patient Profile

Of the 60 patients sustaining major intestinal injuries, the average age was 33.2 years. The male-to-female ratio was 7.5:1. Auto accidents accounted for 77% of the patients, motorcycle accidents claimed 13%, and the remainder were the result of miscellaneous accidents (Table 1).

Eight hundred seventy patients underwent celiotomy for BAT during this 5-year period. The incidence of major bowel injury was 6.9%. The previously quoted incidence of 4.2% did not include mesenteric injuries.<sup>11</sup>

### Diagnosis

All of these 60 patients underwent diagnostic peritoneal lavage. The technique and criteria for positive lavage at this institution have been described elsewhere.<sup>12</sup> The initial lavage was positive in 57 cases (95%). The initial lavage was equivocal in two cases, but repeat lavage at 2 hours was positive in both. The last patient had a truly negative lavage initially, but a repeat lavage was performed at 2 hours because of vague abdominal symptoms. The repeat was also negative. Over the next 12 hours, the patient developed peritonitis and was explored, at which time a solitary perforation of the sigmoid colon was found.

TABLE 1. *Mode of Injury (N = 60)*

Mode of Injury	Number	Per cent
Auto accidents	46	77%
Motorcycle accident	8	13%
Industrial accidents	3	5%
Falls	1	1.7%
Pedestrians struck	1	1.7%
Airplane crash	1	1.7%

### Type and Location of Injuries

There were 83 major injuries among these 60 patients. A synopsis of the type and location of these injuries is given in Table 2. Perforation or transection of the bowel wall occurred on 37 occasions. Twenty-eight of these injuries occurred between the ligament of Treitz and the ileocecal valve, without preference for any specific location. There were only two perforations of the duodenum. The seven remaining perforations or transections were distributed throughout the colon (Fig. 1).

Major mesenteric injuries accounted for 41 of the lesions. There were 24 involving the small bowel, with a predilection for the distal ileum. The colonic mesentery was disrupted seven times; six in the right colon. The remaining ten injuries were avulsions of the root of the mesentery associated with ten superior mesenteric vein lacerations and three superior mesenteric artery tears (Fig. 2).

Severe seromuscular tears (requiring resection) of the colon were present in five patients. Four of these were located in the sigmoid colon, and one was in the transverse colon.

### Associated Injuries

Associated injuries were divided into intraabdominal and extraabdominal. Thirty-four patients (57%) had no other intraabdominal organs injured, while the remaining 24 patients (43%) had at least one other abdominal organ injured. Five patients had three or more intraabdominal injuries. The spleen and liver were the most commonly involved organs (Table 3). Fifteen patients (25%) had more than one major intestinal injury.

Extraabdominal injuries were classified as skeletal, maxillofacial, neurologic, or thoracic. Only 13 of the 60 patients (22%) had trauma limited to the abdomen. Twenty-one had one other system involved, while 26

TABLE 2. *Type of Injury by Location*

	Small Bowel	Colon
Perforation/transection	30	7
Devascularization	34*	7
Severe contusion	0	5

\* Including ten injuries to the root of the mesentery.

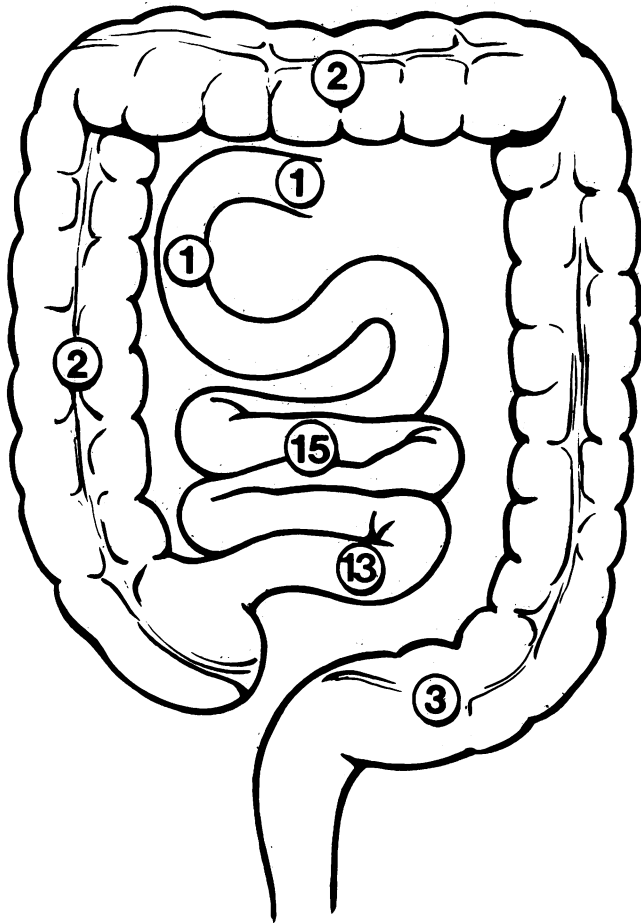


FIG. 1. Perforations or transections throughout the bowel (total = 37).

had two or more systems injured. The most common extraabdominal system involved was the skeletal, followed by maxillofacial, neurologic, and thoracic (Table 4).

#### Treatment

There were 30 patients with perforations of the small bowel. Fifteen (50%) underwent debridement and primary closure, while 13 required resection with anastomosis. One patient had two perforations, which were treated with one resection, and another patient died intraoperatively of other causes before the small bowel perforation was addressed.

Twenty-four patients had ischemic small bowel secondary to mesenteric injury. Twenty-two of these underwent resection with primary anastomosis, while two died intraoperatively before treatment of the bowel injury.

There were seven perforations of the colon. One right colon perforation was closed primarily. One patient had

perforations of the right colon and transverse colon but died before therapy. Another transverse colon perforation was treated with a loop colostomy. There were three sigmoid perforations. One was closed primarily, one had a concomitant right colon injury and was treated by primary closure and proximal colostomy, and one was treated with a sigmoid colostomy.

Of the five colon injuries resulting from mesenteric damage, four were in the right colon. Two of these patients underwent ileostomy with mucus fistula and two were treated with colostomy and mucus fistula. The remaining patient had a transverse colon injury and died intraoperatively of a head injury.

Five other patients had significant local damage to the bowel wall, which required treatment. One in the transverse colon and one in the sigmoid colon required resection with colostomy and mucus fistula. Three others, all in the sigmoid colon, were treated with repair and exteriorization of the injury.

Ten patients had injuries to the root of the mesentery, all with laceration of the superior mesenteric vein, and

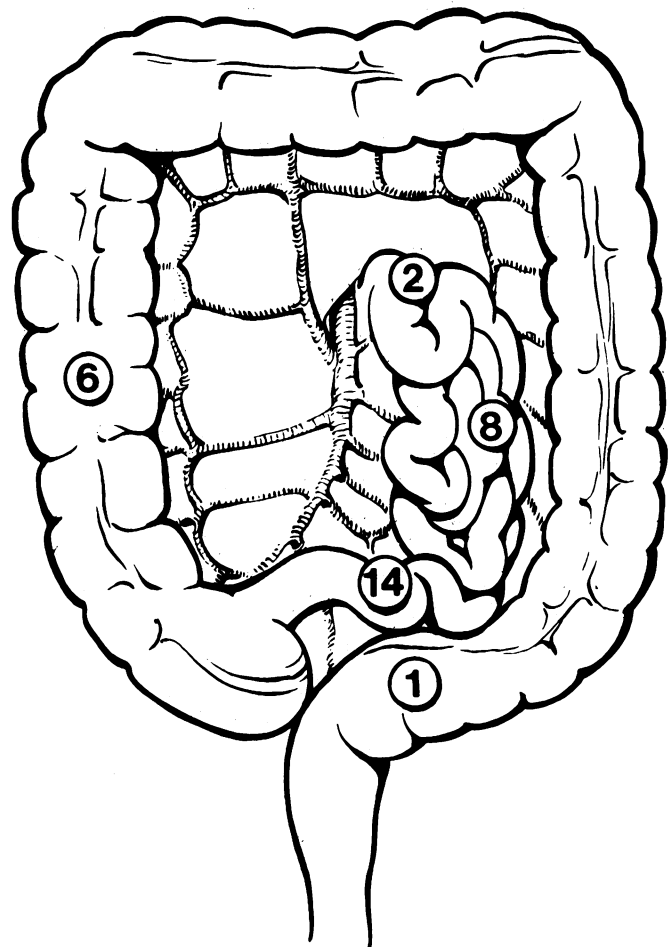


FIG. 2. Mesenteric injuries throughout the intestine (total = 31), excluding ten disruptions of root of mesentery.

three with simultaneous tear of the superior mesenteric artery. All three patients with superior mesenteric artery injuries died. Suture repair of the superior mesenteric vein was performed in six patients with 100% survival; the seventh patient, whose injury extended into the portal vein, died intraoperatively.

### Morbidity and Mortality

There were 16 deaths among the 60 patients (26%). Five of these deaths were the result of serious head injuries. Four other patients had injuries to the root of the mesentery, resulting in death in the operation room. The patient with the missed colon injury on initial lavage suffered sudden death postoperatively from a myocardial infarction. He had a previous history of angina pectoris and hypertension. The remaining six patients suffered late complications as a result of their bowel injuries that contributed, at least in part, to their death. A synopsis of each case is given in Table 5.

Four patients developed seven major complications as a result of the bowel injury. These included wound infection (2), intraabdominal abscess (2), dehiscence (1), short bowel syndrome (1), and fasciitis (1). These patients each had at least one major injury in addition to the bowel injury. All four responded to appropriate therapy and were eventually discharged.

### Discussion

The regionalization of trauma over the past decade has resulted in larger series of unusual injuries managed at specialized centers. This results in better understanding of such processes, potentiating improved treatment and lower mortality rates. This theory has been proven at this institution over the 5-year period of this report.<sup>11</sup> Most publications dealing with blunt intestinal trauma are based on few cases collected over many years.<sup>13-16</sup> Over extended periods, changes in the mode of injury, methods of diagnosis, and methods of treatment can affect results and conclusions on the subject. The patients in this report were identified prospectively during a relatively short period of time. Ninety per cent of the patients were victims of motor vehicle accidents. We feel that these factors make this report an accurate assessment of modern-day blunt intestinal injury.

Sammuel Annan, in 1837, reported the first case of intestinal rupture secondary to blunt trauma in America.<sup>8</sup> Much debate regarding the mechanism of these injuries has since taken place, and many elaborate studies have been done to support various theories.<sup>17-20</sup> Simple reasoning dictates that different mechanisms cause different injuries. Punctate or slit-like perforations often occurring on the antimesenteric border are probably the product of a sudden increase in intraluminal pressure in a fluid

TABLE 3. Associated Intraabdominal Injuries (N = 24)

Organ	No. of Injuries
Spleen	15
Liver	13
Retroperitoneum*†	7
Kidney*	2
Pancreas*	2
Bladder*	2
Diaphragm	1
Gallbladder	1
Total	43

\* Not true of abdominal organs.

† Retroperitoneal hematoma without major organ injury.

or air-filled loop. Robbs reported 54 such lesions in Zulu tribesmen, most caused by a blow to the abdomen with a weighted, roundheaded weapon.<sup>21</sup> The small bowels of almost all victims were distended with large quantities of local beer. These perforations were not surrounded by damaged tissue and did not appear to result from a crushing-type injury. Transections or large perforations surrounded by local tissue hemorrhage are probably the mark left by shearing forces between the abdominal wall and the vertebral column. This mechanism could also damage the associated mesentery. Avulsion-type injuries to the mesentery are the result of tangential forces applied to a fixed point. These forces may be applied directly or indirectly, as in acceleration-deceleration situations.

Whatever the mechanism, the early recognition of these lesions can be difficult. An overlooked bowel injury is perhaps the most dangerous of all abdominal injuries because of the tremendous infectious potential. Repeated studies have shown increased mortality rates to be directly related to delay in diagnosis.<sup>6,17,21</sup> Peritoneal lavage has proven to be extremely useful in the early detection of these injuries.<sup>21,22</sup> It was used successfully in 33 of the 34 patients with isolated bowel injury reported here. Although accurate, occasional cases are missed.<sup>21,23,24</sup>

The literature is abundant with papers on blunt duodenal injury. In some series, these injuries comprise

TABLE 4. Extraabdominal Injuries (77 Injuries in 47 Patients)

No. of Patients (%)	System
32 (53%)	Skeletal—At least one long bone fracture. Often numerous/8 pelvic fractures.
20 (33%)	Facial—Facial fractures or complicated lacerations requiring plastic repair.
19 (32%)	Neurologic—Skull fracture or closed head injury requiring intracranial pressure monitor.
6 (10%)	Thoracic—Fractured ribs, pulmonary contusion, pneumothorax or hemothorax.

TABLE 5. Mortality Directly Related to Complications of Bowel Injury

No.	Age/Sex	Mode of Injury	Bowel Injury	Other Injury	Complication	Time from Accident to Death
1	50 WM	Auto	Avulsion of distal ileum	Ruptured spleen Fracture pelvis	Pelvic abscess → Multiple organ failure	22 days
2	50 WM	Auto	Perforation of distal ileum/devascularization of segment of ileum and right colon	None	Iatrogenic disruption of anastomosis at reoperation for GI bleed → sepsis	18 days
3	15 WF	Auto	Perforation of distal ileum	Pelvic fracture Bilateral femur fracture Radius fracture Ruptured spleen Ruptured bladder	Pelvic abscess with probable infected retroperitoneal hematoma	30 days
4	37 OM	Auto	Perforation of midjejunum Mesenteric hematoma	T <sub>9</sub> fracture and paraplegia Multiple rib fractures	Intraabdominal abscess/sepsis/renal failure	19 days
5*	35 WM	Auto	Perforation of mid small bowel and sigmoid colon	Fractured humerus Fractured tibia-fibula	Missed jejunal injury → sepsis → multiple organ failure	20 days
6	55 WM	Airplane	Mesenteric injury to distal ileum	Laforte III Ruptured spleen Bilateral femur fractures	Intraabdominal abscess/gangrenous cholecystitis	60 days

\* Transferred to MIEMSS Shock Trauma after laparotomy.

30–60% of all bowel perforations from blunt trauma.<sup>13,15</sup> Only two perforations of the duodenum were seen here in 5 years. Coincidentally, only three major pancreatic injuries and one stomach perforation were seen during this period. These structures, because of their location, are fairly well-shielded by the costal margins from large blunt objects, such as steering wheels. They are much more prone to insult from well-localized blows from fists, feet, or small weapons. The duodenum is not routinely mobilized in the absence of bile-staining or localized retroperitoneal bleeding.<sup>11</sup> This maneuver, although simple, prolongs the operation and may incur iatrogenic injury.

The idea that the proximal jejunum and distal ileum are more prone to perforation is entrenched in the surgical literature since early reports.<sup>6,9</sup> We have not found this to be the case in our series, in which less than one half of the perforations occurred in these zones. Others have supported this finding.<sup>17</sup> However, mesenteric injuries do occur more frequently at these points, probably because of the mechanism of injury. One can envision a driver flying forward and upward upon impact, with the bottom of the steering wheel avulsing the bowel from its short mesentery. There was a strong predilection for the distal ileum in the mesenteric injuries encountered here.

Colon injuries occur less frequently than small bowel injuries, probably due to several factors, including lo-

cation and lack of redundancy, which prevents formation of closed loops. Our experience agrees with that of Strate, who found serosal tears to be most common in the transverse colon.<sup>14</sup> This is because of its vulnerable location. Most complete perforations were found in the sigmoid colon, which may be explained by its redundancy, which makes it susceptible to closed-loop formation. At least one report has attributed these rare injuries to lap belts.<sup>24</sup> The right colon was the most common site of devascularizing injuries, which were almost uniformly associated with distal ileum avulsions.

Complete avulsions of the root of the mesentery are uncommon. Those individuals suffering this catastrophe probably die in the field, since bleeding is not contained by the retroperitoneum as in aortic or vena caval injuries. These injuries were uniformly fatal in our limited experience. Partial tears of the superior mesenteric vein can usually be repaired by lateral venorrhaphy. The use of clamps should be avoided with injuries in this region. Bleeding should be controlled with pressure to prevent further iatrogenic injury.

Mortality rates quoted for blunt intestinal trauma range from 10% to 30%. Reports have shown that mortality rises with the number of associated injuries.<sup>4,14</sup> Associated injuries often prolong resuscitation and thus delay treatment. After treatment, these patients are more prone to develop complications as a result of the traumatized state. Alterations in protein metabolism probably

prolong healing, and changes in the immune system make these patients more susceptible to infection. A better understanding of these and other changes that occur in the traumatized patient may someday further improve survival. Early diagnosis and expedient treatment will always be of utmost importance in management of these injuries.

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