

# A Study of Traumatic Small Intestinal Perforation: What Factors Determine Outcome?

Rabin Mandal<sup>1</sup>, Raja Basak<sup>2</sup>

<sup>1</sup>Associate Professor and MS, Department of Surgery, Malda Medical College, Malda, West Bengal, India, <sup>2</sup>Assistant Professor and MS, Department of Surgery, Raiganj Government Medical College, Raiganj, West Bengal, India

## Abstract

**Introduction:** Small bowel injury is common after blunt and penetrating abdominal trauma resulting in significant mortality and morbidity in a generally active population. Delay in diagnosis and treatment results in a worse outcome. Our study aims to delineate the magnitude of the problem in a tertiary care teaching hospital and determine the factors resulting in a poor outcome.

**Materials and Methods:** This institution-based, observational descriptive study was conducted over a period of 15 months. The sample included patients with blunt or penetrating abdominal, trauma with small intestinal perforation. Patients with concurrent major CNS, cardiothoracic, and orthopedic trauma were excluded from the study. Various factors likely to affect final outcome were recorded. The appropriate surgical procedure was performed and post-operative recovery and any complications including mortality data were recorded and analyzed.

**Results and Analysis:** A total of 38 patients were included. Males outnumbered females. Mean age of presentation was 32.03 years signifying a younger population. Motor vehicle accidents and blunt trauma were more common. Mortality rate was 18.4%. The presence of shock at admission and death was significantly related. Delay in surgery significantly increased the length of hospital stay.

**Conclusion:** Small intestinal perforation resulting from abdominal trauma is a condition associated with a very high mortality and morbidity, especially in a young and active population. The efforts to reduce its incidence are beyond this discussion, but measures to reduce its resultant mortality and morbidity are definitely possible and feasible in a well-equipped, tertiary care setting. This requires sincere, well-concerted efforts from all strata of government including health caregivers.

**Key words:** Abdomen, Perforation, Small intestine, Trauma

## INTRODUCTION

The small bowel distal to the ligament of Treitz is approximately 5–6 m in length in the adult, proximal 40% being the jejunum, and the remainder the ileum.

Protected anteriorly only by the abdominal wall musculature and occupying most of the true abdominal cavity, it is anatomically vulnerable to injury.

The jejunum and proximal ileum contain Gram-positive and Gram-negative organisms in  $10^4$ – $10^5$  cfu/ml which rises

to  $10^5$ – $10^8$  cfu/ml in the ileum with a higher number of anaerobes too. This increase in bacterial load in the ileum is likely cause of an increased risk of infection with full-thickness injury in the distal small bowel versus the proximal small bowel.

Small intestinal injury is frequent after abdominal trauma with delay in the diagnosis being a major contributor to morbidity and mortality.

The incidence of small bowel injury (SBI) after penetrating abdominal trauma has been described 21%–60%. Mortality rates range from 10% to 25%, with most caused by associated vascular injuries.

SBI is less common in blunt trauma, being present in 2.7% of all blunt abdominal injuries, although these are associated with a significant mortality rate of 16.3%.

As no widely accepted diagnostic approach has been in use in the diagnosis of blunt SBI, quite a few stable

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**Corresponding Author:** Dr. Raja Basak, Department of Surgery, Raiganj Government Medical College, Raiganj, West Bengal, India.

blunt trauma abdomen cases are managed conservatively which results in significant delayed diagnosis of SBI and consequent morbidity and mortality.

This study not only describes the patterns of SBI after blunt and penetrating trauma but also describes the factors determining outcome in a tertiary care hospital.

## AIMS

The aims of the study were as follows:

To describe the demographic and clinical profile of patients with traumatic small intestinal perforation in a tertiary care hospital.

To study the outcome of those patients.

To describe the factors affecting outcome in patients with traumatic small intestinal perforation.

## REVIEW OF LITERATURE

Aristotle first recognized small bowel perforation from blunt trauma.<sup>[1]</sup>

Hippocrates was the first to report intestinal perforation from penetrating abdominal trauma.

In 1275, Guillaume de Salicet described the successful suture repair of a tangential intestinal wound.

Morbidity and mortality rates were very high over the ages until World War II, where prompt evacuation, improvements in anesthesia, and better understanding and treatment of shock reduced mortality rates to 13.9% for jejunal or ileal injuries and 36.3% if multiple injuries were present.<sup>[2]</sup>

Localized blows to the abdomen and motor vehicle accidents are the most important mechanisms of blunt SBI with falls and bicycle accidents adding up. Contusions, intramural hematomas, full-thickness perforations, and mesenteric avulsions of the small bowel have all been reported. Mechanisms postulated for injury to the intestine to occur include crushing of bowel against the spine, sudden deceleration shearing of the bowel from its mesentery and bursting of a “pseudo closed” loop of bowel owing to sudden increase in intraluminal pressure.<sup>[3]</sup>

Penetrating SBIs are caused by knives, gunshot wounds, and other piercing instruments. Of those with penetration of the peritoneum, only 30% of patients with knife wounds have significant injuries requiring operation, whereas over 80% of patients who suffer gunshot wounds have injuries requiring surgical repair.

Proper diagnosis of the severity of injury requires an accurate history of the traumatic event.

Patients with evisceration of abdominal contents after abdominal stab wound are associated with significant intra-abdominal organ injury in 75% even with no overt clinical signs that would mandate laparotomy<sup>[4]</sup> and require exploration.

A low threshold for laparotomy is appropriate in such situations with blunt injury as seat belt injuries, handle bar injuries, and blows to the abdomen such as being kicked by a horse or other large animal.

Sensitivity of clinical examination to identify patients for laparotomy exceeds 95% for stab wounds and gunshot wounds. Clinical examination of the abdomen has been unreliable in approximately 50% of blunt abdominal trauma patients.<sup>[5]</sup> Significant limitations include patients with head injury and altered level of consciousness, intoxication due to drugs or alcohol, and spinal cord injury. The variable effect of hemoperitoneum from associated solid organ injuries and the presence of distracting injuries (e.g., pelvic fracture) in the multi-injured patients may also limit the clinical reliability of the findings on physical examination. Clinical findings following penetrating SBI may be minimal initially as the luminal content of the small bowel has an almost neutral pH and is relatively sterile; the spill may also be relatively small, limiting the initial inflammatory response.

Diagnostic peritoneal lavage amylase and alkaline phosphatase levels may also be useful in identifying hollow viscus injuries, but the effectiveness of focused assessment with sonography for trauma in the same is unreliable.<sup>[6]</sup>

A CT scan showing unexplained intraperitoneal fluid, pneumoperitoneum, bowel wall thickening, mesenteric fat streaking, free intraperitoneal air mesenteric hematoma, and extravasation of either luminal or vascular contrast<sup>[7,8]</sup> is suspicious of bowel perforation.

Diagnostic laparoscopy is occasionally helpful in avoiding laparotomy in hemodynamically stable patients with penetrating abdominal trauma.<sup>[9]</sup> The major limitation cited with diagnostic laparoscopy is in the relative inability to detect hollow viscus perforations.<sup>[10]</sup> In patients found to have intestinal perforation, it is safest to convert to a laparotomy.

Surgical treatment requires careful inspection of the entire length of the gut.

Mesenteric hematomas adjacent to the bowel wall should be carefully opened and the mesenteric aspect

of the bowel inspected for injury. Obvious serosal tears should be closed with interrupted silk sutures. A Grade I intramural hematoma can be safely inverted with 3–0 or 4–0 silk seromuscular sutures. Full-thickness small bowel perforations including <50% of the circumference (Grade II) are repaired by careful debridement and primary closure. The preferred method is to use a two-layer closure with a continuous polyglactin suture for the inner layer and interrupted silk sutures for the outer layer. A transverse closure is preferable to prevent strictures. Injuries to more than 50% of the small bowel circumference should usually be resected because of the high likelihood of luminal narrowing with primary closure. Complete transection of the bowel (Grade IV) is treated by resection of the injured bowel and its adjacent blood supply followed by anastomosis. Grade V injuries require resection of the bowel with anastomosis.

An intra-abdominal septic complication most often presents as an intra-abdominal abscess. Anastomotic failure may present as a contained leak, diffuse fecal peritonitis, or as an enterocutaneous fistula.<sup>[11]</sup>

In general, jejunal resections are better tolerated than ileal resections. Ileal resection removes the “ileal breaking mechanism” which may cause decreased transit time throughout the gut. This may result in profuse diarrhea and significant fluid and electrolyte imbalances. Short bowel syndrome may occur in adults with <200 cm of residual small gut.<sup>[12]</sup>

## MATERIALS AND METHODS

### Study Design

It is an observational descriptive study carried out at a tertiary care hospital over a period of 15 months. Patients with blunt or penetrating trauma to the abdomen were screened and those with small bowel perforation were included in the sample. Patients with concurrent major CNS, cardiothoracic, and orthopedic trauma were excluded from the study. Parameters studied included age, gender of the patient, time since injury, type of injury (blunt or penetrating), other abdominal injuries with site, and grade of small bowel perforation. The appropriate surgical procedure was performed (primary closure of perforation, resection and anastomosis, and stoma formation), and post-operative recovery and any complications were recorded. Comorbidities were also included in the study parameters. A follow-up period of 6 months was carried out.

The collected data were analyzed using standard statistical methods with SPSS v25 statistical software including frequency analysis and descriptive statistics.

## RESULTS AND ANALYSIS

A total number of 38 patients ( $n = 38$ ) with traumatic SBI were included in the study. Males numbered 32 (84.2%) with 6 (15.8%) females. Ages ranged from 17 years to 48 years (mean = 32.03 years). Most of them suffered from blunt trauma ( $n = 31$ , 81.6%) and incidence of penetrating injuries was 7 (18.4%) [Table 1].

Mechanism of trauma was motor accidents ( $n = 16$ ; 42.1%), pedestrian accident ( $n = 7$ ; 18.4%), fall ( $n = 6$ ; 15.8%), sports injury ( $n = 5$ ; 13.2%), and physical assault ( $n = 4$ ; 10.5%). [Table 1].

Time since injury ranged from 5 to 112 h with a mean of 34.49 h (SD 31.616).

An erect abdominal X-ray showed free gas under dome of diaphragm ( $n = 17$ ; 44.7%) as opposed to no gas ( $n = 21$ ; 55.3%) under diaphragm.

Shock at admission was present in 8 (44.7%) of patients, whereas 30 (55.3%) patients presented without shock.

Parts of the bowel injured were proximal jejunum ( $n = 17$ ; 44.7%), distal jejunum ( $n = 6$ ; 15.8%), proximal ileum ( $n = 4$ ; 10.5%), distal ileum ( $n = 8$ ; 21.1%), and a combination ( $n = 3$ ; 7.9%).

Grade of SBI suffered was Grade II ( $n = 22$ ; 57.9%), Grade III ( $n = 7$ ; 18.4%), Grade IV ( $n = 3$ ; 7.9%), and Grade V ( $n = 6$ ; 15.8%).

Surgical treatments performed were primary repair ( $n = 12$ ; 31.6%), resection and anastomosis ( $n = 10$ ; 26.3%), feeding tube insertion through the perforation ( $n = 10$ ; 26.3%), and ileostomy ( $n = 6$ ; 15.8%).

Other visceral injuries noted were mesentery ( $n = 9$ ), colon ( $n = 3$ ), liver ( $n = 2$ ), spleen ( $n = 1$ ), and stomach ( $n = 1$ ).

Post-operative morbidity included sepsis ( $n = 8$ ; 21.1%), surgical site infection ( $n = 6$ ; 15.8%), pneumonia ( $n = 3$ ; 7.9%), diarrhea ( $n = 2$ ; 5.3%), and wound dehiscence ( $n = 2$ ; 5.3%) [Table 2].

**Table 1: Mechanism of trauma**

Mechanism of trauma	Frequency	Percentage
Motor accident	16	42.1
Pedestrian accident	7	18.4
Assault	4	10.5
Fall	6	15.8
Sports accident	5	13.2

Hospital stay ranged from 7 to 26 days with a mean of 16.29 days (SD 5.666).

Seven patients died postoperatively, six due to sepsis and one due to pneumonia (mortality rate of 18.4%).

Statistical analysis of the data shows up factors such as age, gender, time since injury, presence of shock on admission, free gas on AXR, grade of SBI, and associated visceral injury which may or may not affect outcomes such as mortality, post-operative complications (morbidity), and length of hospital stay.

No significant correlation could be found between these factors and outcomes ( $P > 0.05$ ) except that the presence of shock at admission and death was significantly related ( $P = 0.009$ ). Length of hospital stay was significantly affected by time elapsed from injury to surgical procedure ( $P = 0.001$ ) and mildly by finding of free gas on AXR ( $P = 0.049$ ) [Table 3].

## DISCUSSION

The incidence of SBI associated with abdominal trauma ranges from 3 to 18%<sup>[13]</sup> and the frequency of SBI in blunt abdominal trauma is 18.1% in recent trauma literatures.<sup>[13]</sup> Males are significantly more affected compared to females.<sup>[13]</sup> In our study, we have seen that greater proportion of males was affected compared to females (M:F = 5.3:1). Most common age group affected in our study was 25–45 years (mean 32.03 years). In our study, various mechanisms of trauma were noted, among whose motor vehicle accident was the predominant cause of SBI (42%); this has also been supported by recent trauma literatures.<sup>[13,14]</sup>

**Table 2: Post-operative complications**

Complication	Frequency	Percentage
None	17	44.7
Sepsis	8	21.1
Surgical site infection	6	15.8
Pneumonia	3	7.9
Diarrhea	2	5.3
Wound dehiscence	2	5.3

**Table 3: Correlation between factors and outcomes (P-values from two-tailed test)**

Factors	Mortality	Complications	Length of stay
Age	0.870	0.491	0.144
Gender	0.907	0.479	0.802
Time since injury	0.238	0.714	0.001 (Sig)
Shock	0.009 (Sig)	0.816	0.664
Free gas on AXR	0.076	0.673	0.049 (Sig)
Grade of SBI	0.406	0.612	0.147
Associated injury	0.401	0.174	0.468

AXR: Abdominal X-ray, SBI: Small bowel injury; Sig: Significant ( $P < 0.05$ )

It is seen that cases of blunt trauma were more than penetrating ones causing small bowel perforation.<sup>[12]</sup> In our study, the incidence of blunt and penetrating trauma responsible for SBI was 81.6% and 18.4%, respectively. We have noticed that most of our patients (52.6%) were operated within 24 h since injury; this was also reflected in the previous studies.<sup>[15]</sup>

We observed that the proximal jejunum (44.7%) and distal ileum (21%) were more prone to perforation. This is mainly due to their location and lack of redundancy in this part of the bowel. This has also been observed in earlier reports.<sup>[16]</sup> Some studies differ from this view.<sup>[17]</sup>

Dauterive *et al.* in their study of 60 patients found that  $< 1/2$  of the perforations occurred in these zones (proximal jejunum and distal ileum).<sup>[17]</sup> However, they found that mesenteric injuries do occur more frequently than it was assumed earlier. We have seen mesenteric injury occurred in 23.7% of cases in our study. Associated colonic injury occurred frequently with small intestinal injuries but less in numbers (7.9%) compared to the mesenteric injury. This has also been reported in other studies.<sup>[17]</sup>

Isolated SBI was noted in 57.9% of cases in our study. Regarding the grade of injury in small bowel perforation, Grade II injuries were the most common (57.9%) as in other literature.<sup>[16]</sup>

In our study, the most commonly performed operative procedure was primary repair (31.6%). Simple closure is usually adequate for single perforation of the small intestine, but more extensive injuries such as multiple perforations and gangrene from mesenteric injuries usually require resection and anastomosis.<sup>[18]</sup> In our study, we have seen that 26.3% of injuries were managed by resection and anastomosis. Fang *et al.*<sup>[19]</sup> observed that a delay in surgery of more than 24 h after the injury in patients with perforated SBI did not significantly increase mortality, but was associated with a dramatic increase in the incidence of complications. Complications in our study were sepsis in 21.1%, surgical site infection in 15.8%, pneumonia in 7.9%, wound dehiscence in 5.3%, and diarrhea in 5.3% which is comparable to other studies.<sup>[19]</sup>

The mortality rate (18.4%) is within the range of previous studies (4–32%). Deaths mostly happened in cases associated with multiple injuries beside SBI.

## SUMMARY AND CONCLUSION

We have tried to describe the clinicodemographic profile, the outcome, and also the factors determining outcome of the patients of traumatic small intestinal perforation in a tertiary care hospital.



Most of our patients were male (81.25%) and the age group, affected most was between 25 and 45 years of age (63.2%). The complete sentence should be In our study blunt trauma (81.6%) due to motor vehicle accident (42.1%) was the predominant cause of traumatic SBI.

Most patients (52.6%) presented to us in <24 h of injury. Most common part of small bowel affected was proximal (44.7%) and Grade II injury (55.26%) was predominant among them. Mesenteric injury was the most common associated injury noted (23.7%).

Isolated small bowel perforation was found in 57.9% of cases.

Most common operative procedure undergone was primary repair (31.6%) of the perforation. There were many complications noted, most commonly was sepsis (21%). Most of the patients were discharged in between 7 and 14 days (39.4%). Mortality rate is approximately 18.4% in our study. In our study, there are significant correlations between the presence of shock on admission and mortality and also time since injury and time spent in hospital stay. Overall, morbidity and mortality were associated with advanced age, delayed presentation, higher grade of injury, and associated injury.

Traumatic small bowel perforation is an entity which is seen mostly in outdoor working, young, male population due to road accidents. It has a significant morbidity and mortality in young and physically active population. Morbidity and mortality are mostly due to delayed presentation after injury, delay in diagnosis and associated injuries. Hence, early clinical suspicion and timely intervention may help to reduce its impact.

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