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Gastrointestinal tract perforation following blunt abdominal trauma: an institution's experience

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Abstract
Purpose Traumatic perforation of the gastrointestinal tract (GIT) poses numerous challenges for surgeons worldwide. We aimed to review our institution's experience and highlight the pertinent issues in managing this problem.
Methods A retrospective review was performed for all patients with perforation of the GIT following traumatic blunt injuries.
Results Twenty-one patients, with a median age of 40 years, formed the study group, all of whom underwent surgery. Four patients were sent straight to the operating theater from the emergency department due to hemodynamic instability, while another two patients had pneumoperitoneum on their X-rays. Computed tomography (CT) scan was performed in 15 patients, with the findings of pneumoperitoneum ($n = 7$, 46.7%) and free fluid without solid organ injury ($n = 9$, 60.0%) being the most common result. The jejunum ($n = 11$, 52.4%) and ileum ($n = 5$, 23.8%) were the most common sites of perforation. Direct repair was performed in 9 (42.9%) patients, while resection of the perforated segment(s) was performed in the remaining 12 (57.1%) patients. Other associated intra-abdominal injuries included mesenteric ($n = 6$, 28.6%) and splenic lacerations ($n = 4$, 19.0%). Surgery was performed within 8 h of the accident in only 11 patients (52.4%). Some of the complications included wound infection ($n = 7$, 33.3%) and intra-abdominal abscesses ($n = 3$, 14.3%). Two patients underwent relook laparotomy after an initial damage control laparotomy.
Conclusion Prompt and early surgery for traumatic gastrointestinal perforation is advised. Any abnormal CT scans warrants either surgery or close monitoring. Direct repair of the perforation is preferred, if possible.

Keywords Perforation · Hollow viscus · Blunt trauma · Gastrointestinal tract

Introduction

Though perforation of the gastrointestinal tract (GIT) after blunt abdominal trauma is uncommon, its consequences can be dire [1]. Numerous issues have posed significant challenges to surgeons worldwide in its management. With the increasing adoption of non-operative management for blunt abdominal trauma [2], the accurate diagnosis of any perforation is of paramount importance, as delay could result in a higher incidence of morbidity [1]. Furthermore, there is no consensus on the most optimal surgical method in tackling the perforation [3]. Thus, the aims of our study were to review our institution's experience in managing GIT perforation following blunt abdominal trauma and to highlight the pertinent issues surrounding this problem.

Methods

Study population

All patients in this study were treated at Tan Tock Seng Hospital from March 2003 to November 2007. Tan Tock Seng Hospital is a 1,300-bed hospital in Singapore that

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provides medical care to over 1.5 million people. It handles the highest number of trauma patients in Singapore and admits an average of 1,000 serious trauma cases yearly, of which 96% were for blunt injuries, with 40% of trauma admissions having an injury severity score (ISS) of more than 16.

A review of a prospective electronic database of all patients with perforation of the GIT from blunt abdominal trauma was performed. Patients were excluded if they suffered penetrating injuries or died in the emergency department. The GIT in our study commenced from the cardioesophageal junction to the rectum at the level of the peritoneal reflection.

The data recorded included age, gender, mechanism of injury, ISS, hemodynamic status at admission, radiological investigations, time from accident to operative intervention, site of perforation, other associated injuries, details of any surgical intervention, length of hospitalization, and the eventual outcome. All trauma patients were managed by the only dedicated surgical trauma team in the institution.

Hemodynamic instability in our study was defined as a heart rate $\geq$100 beats per minute (bpm) with a systolic BP $\leq$90 mmHg. Typical radiological investigations include chest X-ray and pelvic X-ray. Computed tomography (CT) scans are also performed for all patients after blunt abdominal trauma if they are hemodynamically stable.

Indications for laparotomy in our institution in this series included hemodynamic instability from suspected intra-abdominal cause or clinical deterioration after attempted non-operative management and/or any suspicious radiological findings of significant hollow viscus injury. The surgical repair used in our study included primary repair of the perforation or resection of the affected segment, with (stapled or hand-sewn) or without anastomosis.

Results

Twenty-one patients formed the study group. The median age of this group was 40 (range, 17–65) years, with a male (90.5%) predominance. Automobile accidents accounted for 66.7% of the injuries. The median Glasgow Coma Scale (GCS) score and ISS were 15 (range, 8–15) and 16 (range, 5–50), respectively. A total of seven patients were hemodynamically unstable on admission, while the median BP and HR of the study group were 115 mmHg (range, 52–221) and 96 bpm (60–124), respectively. All patients underwent surgical intervention. Table 1 describes the characteristics of the study group.

Fifteen (71.4%) patients had pre-operative CT scan performed. Of these 15 patients, 13 (86.7%) were sent to the operating theater after the scans were evaluated. The remaining 2 (13.3%) patients were initially managed non-operatively but were operated subsequently after clinical deterioration. A total of 6 (28.6%) patients were sent straight to the operating theater without any CT scan: 4 (19.0%) were due to significant hemodynamic instability, while 2 (9.5%) had pneumoperitoneum on chest X-ray.

Table 1 Characteristics of the 21 patients with gastrointestinal tract (GIT) perforation

	n (%)
Median age (years)	40 (17–65)
Gender	
Male	19 (90.5)
Female	2 (9.5)
Mechanism of Injuries	
RTA	14 (66.7)
Fall	4 (19.0)
Assault	1 (4.8)
Other	2 (9.5)
Median GCS	15 (8–15)
Median ISS	16 (5–50)
Median BP (mmHg)	115 (52–221)
Median HR (beats per minute)	96 (60–124)
Number of patients who were hemodynamically unstable on admission	7 (33.3)
Median length of hospital stay (days)	12 (1–86)
Surgical intervention	21 (100.0)
Pre-operative CT scans	
Yes	15 (71.4)
Sent straight to operating theater after CT scan	13 (61.9)
Attempted initial non-operative management	2 (9.5)
No	6 (28.6)
Sent straight to operating theater due to hemodynamic instability	4 (19.0)
Pneumoperitoneum on CXR	2 (9.5)
Outcome	
Alive	20 (95.2)
Died	1 (4.8)

The findings of the CT scans included pneumoperitoneum ($n = 7$, 46.7%), free fluid without solid organ injury ($n = 9$, 60.0%), bowel thickening ($n = 3$, 20.0%), and significant solid organ injury ($n = 5$, 33.3%). Both patients who failed non-operative management did not have pneumoperitoneum on their CT scans; instead, significant free fluid was present in both patients, one with solid organ injury and one without. Table 2 summarizes the various CT findings.

Surgical interventions and other injuries

The jejunum ($n = 11$, 52.4%) was the most common site of perforation, followed by the ileum ($n = 5$, 23.8%).

Table 2 Computed tomography (CT) scan findings of the 15 patients with hollow viscus perforation

CT scan findings	*n* (%)
Extraluminal gas	7 (46.7)
Free fluid without significant solid organ injuries	9 (60.0)
Bowel thickening	3 (20.0)
Significant solid organ injury	5 (33.3)

Table 3 Site of GIT perforation and the details of surgical repair performed in the 21 patients

	n (%)
Site of perforation	
Isolated jejunum	10 (47.6)
Isolated ileum	4 (19.0)
Jejunum and ileum	1 (4.8)
Colon	4 (19.0)
Stomach	1 (4.8)
Duodenum	1 (4.8)
Types of surgical repair	
Direct repair	9 (42.9)
Resection	12 (57.1)
Stoma	3 (14.3)
Hand-sewn anastomosis	3 (14.3)
Stapled anastomosis	4 (19.0)
Both hand-sewn and stapled anastomoses	2 (9.5)
Timing of surgery	
≤8 h	11 (52.4)
>8 h	10 (47.6)

Colonic perforation was present in 4 (19.0%) patients, while perforation of the stomach ($n = 1$, 4.8%) and duodenum ($n = 1$, 4.8%) were less frequent. One patient (4.8%) had synchronous perforation of the jejunum and ileum. Table 3 illustrates the sites of perforation and the details of the surgical repair.

Direct repair was performed in 9 (42.9%) patients using interrupted absorbable sutures, while resection of the perforated segment(s) was performed in the remaining 12 (57.1%) patients. In the latter group, three had stoma created, with another three having their anastomosis hand-sewn, and another four had stapled anastomosis. The remaining two patients had a combination of hand-sewn and stapled anastomoses for numerous resections due to the presence of significant injuries to part of the remaining bowel, necessitating resection.

Other associated intra-abdominal injuries included splenic lacerations ($n = 4$, 19.0%), kidney lacerations ($n = 2$, 9.5%), mesenteric lacerations ($n = 6$, 28.6%), and inferior vena cava laceration in one patient. No patient with liver injury was identified in this series. Apart from the intra-abdominal injuries, other injuries included long bone fracture ($n = 8$, 38.1%), thoracic injuries ($n = 4$, 19.0%), pelvic fracture ($n = 3$, 14.3%), and brain injury ($n = 1$, 4.8%) (Table 4).

Table 4 Other associated injuries in the 21 patients

Associated injuries	*n* (%)
Splenic laceration	4 (19.0)
Kidney laceration	2 (9.5)
Mesenteric laceration	6 (28.6)
Inferior vena cava laceration	1 (4.8)
Long bone fracture(s)	8 (38.1)
Thoracic injury	4 (19.0)
Pelvic fracture	3 (14.3)
CNS injury	1 (4.8)

Surgery was performed within 8 h of the accident in only 11 patients (52.4%). In the other ten patients who underwent their operations >8 h following the accident, two were due to the failure of non-operative management, as described above. Four presented late to the emergency department, ranging from 8 h to 3 days after their initial accident. The remaining four patients were initially sent to the surgical intensive care unit (SICU) or high dependency unit (HDU) for further resuscitation and stabilization.

Outcome

Only one patient in our series perished from his injuries; he was already in circulatory shock and had impaired GCS score on presentation. He was sent straight from the emergency department to the operating theater. His high ISS (50) was contributed by splenic laceration, perforated jejunum, several long bones, and pelvic fractures. After undergoing damage control surgery, he was sent to the SICU for further resuscitation, but it failed to revive the patient.

Post-operative complications were present in 12 (57.1%) patients. Three (14.3%) had intra-abdominal abscesses, for which radiologically guided percutaneous drainage was necessary in one patient. Other notable complications

Table 5 Surgical intervention and operative outcome in our series

Outcome	*n* (%)
Discharged well with no significant complications	9 (42.9)
Intra-abdominal collection	3 (14.3)
Wound infection	7 (33.3)
Chest infection	4 (19.0)
Septicemia	4 (19.0)

included wound infection ($n = 7$, 33.3%), chest infection ($n = 4$, 19.0%), and septicemia ($n = 4$, 19.0%) (Table 5).

Two patients underwent re-laparotomy. The first patient had a colostomy created in the second operation after the perforated colon was stapled off in the first due to hemodynamic instability. Similarly, in the second patient, the abdomen was not closed in the initial operation and, hence, a second look laparotomy was required for the closure of the abdomen. The median length of stay in the hospital was 12 (range, 1–86) days.

Discussion

Though the incidence of traumatic GIT perforation is very low, its exclusion is vital in the success of any non-operative management in blunt abdominal injuries. Delayed treatment is associated with higher risks of developing complications such as sepsis, intra-abdominal abscess, and wound dehiscence [1].

Modality of diagnosis

In the event that any patient is hemodynamically unstable after blunt abdominal trauma, surgical intervention to achieve hemostasis is mandatory. However, in the majority of patients who are hemodynamically stable, the different diagnostic modalities to determine the presence of any GIT perforation would range from radiographs, focused assessment with sonography for trauma (FAST), computed tomography (CT) scan, to diagnostic peritoneal lavage (DPL).

The presence of free gas under the hemi-diaphragm with associated clinical evidence of peritonism would naturally mandate exploratory laparotomy. But, more importantly, its absence does not exclude significant GIT injuries [4]. On a similar note, while FAST is associated with high specificity and sensitivity in detecting intra-abdominal fluid, it is unable to determine the types and details of the injuries sustained [5]. This significantly limits the role of FAST in the management of blunt GIT injuries.

CT scan of the abdomen and pelvis has become indispensable in the evaluation of the stable patients after blunt abdominal trauma [5]. Some of the typical features that are diagnostic of hollow viscus perforation would include pneumoperitoneum, discontinuity of bowel wall, and extravasation of contrast materials. Other suggestive features would include free fluid without solid organ injury, bowel wall enhancement, bowel wall thickening, and bowel dilatation [6, 7]. Apart from diagnosing GIT injuries, CT scan is indispensable to diagnose other significant injuries non-operatively. However, CT scan is not foolproof, as seen in one of our patients who had a missed diagnosis of perforated viscus, as the initial CT scan showed free fluid associated with significant solid organ injuries in the absence of pneumoperitoneum. But, perhaps, the most important point to highlight from our series is that none of the CT scans in our series was normal. Hence, the presence of any abnormal findings would either indicate the need for immediate surgery and/or close monitoring.

Because of the high sensitivity and relatively low specificity of DPL for injuries needing repair, patients with blunt abdominal trauma were once subjected to more frequent laparotomy [8]. Although many of these laparotomies were non-therapeutic, there were very few missed abdominal injuries after the surgical procedure. The consequences of non-therapeutic laparotomy are not trivial [9]. In addition, the presence of blood may indicate a solid organ injury or a significant pelvic fracture, which could have been managed non-operatively. Furthermore, DPL could miss significant hollow viscus injury, as the bowel may not be ischemic or perforated for several hours after presentation and the introduction of air and fluid from DPL will only confuse findings from subsequent CT scans [8].

Surgical techniques in handling the perforation

If possible, primary repair of the defect would be the most ideal if technically feasible, rather than risking the possible complications of an anastomosis [10]. However, in situations when serious injuries were encountered, such as numerous sites of perforation, if the perforation involved more than 50% of the circumference, the presence of mesenteric, injuries or other significant bowel injuries, such as ischemic bowel, then bowel resection would be necessary [10].

Numerous reports have compared the usage between hand-sewn and stapling anastomoses for injured bowel after blunt trauma [10, 11]. While stapled anastomosis has been associated with an increased rate of post-operative complications such as intra-abdominal abscess and anastomotic dehiscence with leakage [3], the ease and speed of which it can be performed could be vital in any critically injured patient. The increased complication rates have been postulated to be due to the edematous bowel from the initial injury or from the resultant fluid resuscitation. In addition, higher complication rates of colonic to small bowel anastomosis have been reported when comparing similar techniques [11]. This difference is attributed to the small bowel's inherent ability to heal much better than the colon due to its vascular supply.

Timing of surgery

Though there appeared to be no relation between the timing of surgery from the accident to the various complications in our series, it has been shown in other series that delay in surgery of >8 h for small bowel perforation has been

associated with significant mortality and morbidities, such as septicemia, intra-abdominal abscess, and wound dehiscence [1].

Conclusion

Gastrointestinal tract (GIT) perforation following blunt trauma poses numerous challenges for surgeons worldwide. The authors advocate the usage of computed tomography (CT) scans for further assessment of the abdomen in hemodynamically stable patients. Any abnormal CT scan either warrants surgery or close monitoring. Prompt and early surgery is advised. Direct repair of the perforation is most ideal, but if anastomosis is required, the hand-sewn technique is preferred.

Conflict of interest There are no financial or other interests with-regard to the submitted manuscript that might be construed as a conflict of interest.

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