The role of laparoscopy in the management of patients with isolated blunt abdominal trauma

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Objective

To assess the role of laparoscopy in diagnosis and management of patients with isolated blunt abdominal trauma (IBAT).

Patients and methods

This was a prospective study of 50 patients who were hemodynamically stable (systolic blood pressure ≥90 mmHg) experiencing IBAT who underwent diagnostic and/or therapeutic laparoscopy at the emergency department of Sohag University Hospital. Inclusion criteria were hemodynamically stable patients with IBAT. Exclusion criteria were marked hemodynamic instability, penetrating abdominal trauma, polytraumatized patients, increased intracranial tension, and contraindications for laparoscopy. After a primary survey according to Advanced Trauma Life Support principles, all patients were investigated by pelvi-abdominal ultrasound, computed tomography, chest and abdominal plain radiograph, and other routine laboratory investigations.

Results

A total of 50 stable patients with IBAT underwent urgent laparoscopy. Of them, 32 (64%) patients had therapeutic laparoscopy, whereas 18 (36%) patients had diagnostic laparoscopy. A total of 18 (36%) patients were converted to therapeutic laparotomy. Severely damaged spleen, liver, small intestinal, colon, and stomach injuries were the causes of conversion. Road traffic accident (24%) was the commonest cause of injury. Spleen was the commonest affected organ [18 (36%) patients], followed by the liver [10 (20%) patients]. Pain (visual analog scale of pain) and hospital stay were significantly increased (P=0.0001and 0.001, respectively) in converted (laparotomy) cases in comparison with nonconverted (completed laparoscopy) cases. Postoperative complications, such as wound infection, hematoma, intra-abdominal hemorrhage, wound dehiscence, and reexploration were significantly increased in converted cases in comparison with nonconverted cases (P=0.002, 0.01, 0.01, 0.01, and 0.001, respectively).

Conclusion

Laparoscopy in blunt abdominal trauma is safe, accurate, and feasible. Hemodynamic stability of the patient and surgical expertise in advanced laparoscopy are the prerequisites. The most important advantages of laparoscopy are reduction of nontherapeutic laparotomy rate, reduction of operative period, shortening of hospital stay, and reduction of postoperative pain and postoperative complications.

Keywords:
isolated blunt abdominal trauma, laparoscopy, laparotomy

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Introduction

The commonest cause of blunt abdominal trauma (BAT) in metropolitan trauma centers is the motor car accidents. Moreover, falls from height, work-related injuries, automobile-pedestrian accidents, and assaults are common [1]. The incidence of BAT requiring laparotomy is 6%, with most frequently injured organs being spleen (40–55%), liver (35–45%) and retroperitoneum (5%) [2]. The decision regarding nonoperative conservative treatment or surgery in BAT requires a precise diagnosis, which is not always possible with advanced imaging techniques. Diaphragmatic or intestines injuries may be over-looked and lead to great danger. Indications for laparotomy have been generous, to the extent that up to 41% of laparotomies turn out to be nontherapeutic [3]. Trauma is the cause of majority of fatalities worldwide in people under the age of 35 years [4]. Mechanisms of blunt trauma account for 78.9–95.6% of injuries [5]. The abdomen being affected in 6.0–14.9% of all traumatic injuries [6]. The prognosis of BAT in most cases depends not only on the extent of abdominal existing injuries but also on prompt therapy. Thus, measures for diagnosis have to clarify accurately and rapidly whether laparotomy has to be performed or not. Difficulties in decision making for the surgeons arise especially in cases of BAT where diagnostic imaging [ultrasonography (US) and computed tomographic (CT) scan] does not lead to clear-cut results. Laparoscopy has gained widespread acceptance as a useful tool in the diagnosis and management of patients with blunt abdominal injuries [7]. The routine use of laparoscopy can achieve a sensitivity of 90–100% in abdominal trauma. This can reduce the number of unnecessary laparotomies and the related morbidity [8]. Laparoscopy can be performed effectively and safely in stable patients with traumatic abdomen. The most important advantages are reduction of the nontherapeutic laparotomy rate, shortening of hospitalization, reduction of morbidity, and cost-effectiveness [9].

Hemodynamically stable patients with isolated blunt abdominal trauma (IBAT) underwent laparoscopy for select indications, including the following [10]:

(1) Suspected hollow viscous injuries (as indicated by clinical or radiological findings).
(2) Failure of nonoperative management for injured spleen and liver.
(3) Isolated intraabdominal fluid accumulation of uncertain origin shown on clinical findings and CT films.
(4) Patients had no contraindications of pneumoperitoneum (severe head injury or cardiopulmonary insufficiency).
(5) Unclear abdomen after blunt trauma.

The aim of this study was to assess the value of laparoscopy and its role in diagnosis and management of patients with IBAT.

Patients and methods

This was a prospective study of 50 patients who were hemodynamically stable (systolic blood pressure ≥90 mmHg) after a primary survey according to Advanced Trauma Life Support (ATLS) principles, aged from 20 to 65 years and from both sexes with IBAT. All patients presented with abdominal pain and positive signs (tenderness, rebound tenderness, and diminished/absent bowel sounds) were selected to undergo diagnostic and/or therapeutic laparoscopy at the emergency departments of Sohag University Hospital, Egypt, in the period from August 1, 2019, to July 30, 2020.

Inclusion criteria

(1) Hemodynamically stable patients with IBAT (systolic blood pressure ≥90 mmHg), after a primary survey according to ATLS principles were included.

Exclusion criteria

The following were the exclusion criteria:

(1) Marked hemodynamic instability.
(2) Penetrating abdominal trauma.
(3) Polytraumatized patients.
(4) Increased intracranial tension patients.
(5) Patients with contraindications (general or local) for laparoscopy, such as decompensated cardiac patients and patients with previous major abdominal surgery expecting marked intraabdominal adhesions.
(6) Stable patients not in need for any intervention for conservative management.
(7) Patients with definite occurrence of major abdominal injury that cannot be managed laparoscopically, for example, pancereaticoduedenal injury.

Preoperative preparation of patients

After a primary survey according to ATLS principles, all patients received analgesics and intravenous antibiotics. Informed written consent was taken from each patient after receiving an explanation of the study protocol to diagnostic or therapeutic laparoscopy and exploratory laparotomy whenever needed. All patients were subjected to proper history taking, including age, sex, mode, time and mechanism of trauma, time of last meal, and associated medical illness. Proper general and local examinations were conducted. All patients underwent the following: (a) laboratory examination, including complete blood count at admission and to be repeated after 6 or 12 h for selected cases, kidney and liver functions, coagulation profile, serum sodium, serum potassium, serum amylase, and blood sugar levels, and (b) radiological examination: chest radiography, radiograph abdomen (erect), pelvi-abdominal US [Focused Assessment with Sonography in Trauma (FAST)], and pelvi-abdominal CT.

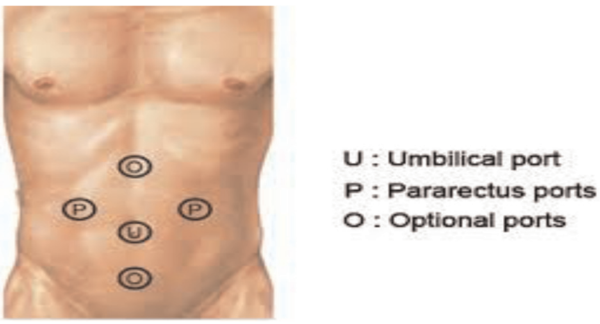
Operative technique [11]

Laparoscopic evaluations were performed in the operating room, with generally anesthetized patients, by a team with significant experience in emergency laparotomy and laparoscopy. Pneumoperitoneum with carbon dioxide was established via an open technique at the umbilicus or a veress needle, and a forward-viewing laparoscope (30°) was inserted. Two further trocars of

5–10 mm are introduced on both sides at level of umbilicus at mid-clavicular line; other optional trocars may be added if needed (Fig. 1). Intra-abdominal pressure was limited to 15 mmHg.

Standard examination included inspection of the liver and spleen for bleeding and a check for hollow viscous injury from rectum to stomach. Assessment of small intestine from ileocecal valve to ligament of Treitz's was done using a traumatic bowel graspers; small intestine and mesentery were elevated and appraised in segments by crossing the graspers. The reverse sides were similarly viewable (Fig. 2). This approach was repeated until reaching ligament of Treitz's. Inspection of the colon from cecum to rectum was done. Piercing of the lesser sac through gastrocolic ligament was done allowing visualization of posterior wall of the stomach and body and tail of the pancreas.

Figure 1



Ports of laparoscopy in blunt abdominal trauma.

Any perforated bowel detected was closed by linear stapling (endo-GIA) or simply sutured (3–0 vicryl or silk) in the course of the procedure or by laparotomy if needed. If segmental resection was needed, a mini-laparotomy was performed by extending the umbilical port to permit laparoscopy-assisted extracorporeal surgery or by laparotomy if needed. Mesentery injury bleeding was controlled by cauterization (Ligasure or Harmonic scalpel) or suture ligation. Big amounts of spilled soilage or clotted hematoma not amenable to aspiration by conventional mode of endo-suction were evacuated by direct insertion of a silastic tube through a 12-mm port.

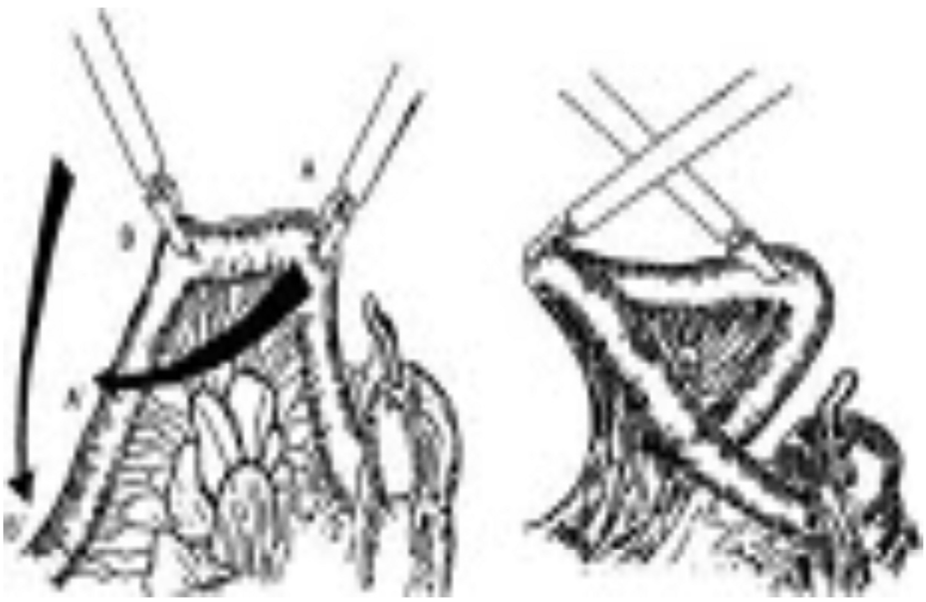
Patient assessment postoperatively

Postoperative assessment included observation of patients for vital data, hemoglobin level, return of intestinal function, pain assessment [by visual analog scale of pain (VAP) was used with the results drawn on 10 cm scale ranging from 0 (no pain) to 10 (worst pain)], the mechanisms of injury, operative technique, operative time, length of hospital stay, and complications. Discharge of patients occurs after return of normal bowel functions, drain removal, and any complication was ruled out.

Statistical analysis

Data were analyzed using STATA, version 14.2 (Stata Statistical Software: Release 14.2; StataCorp LP., College Station, Texas, USA). Quantitative data were represented as mean, SD, median, and range. For the data that were not normally distributed,

Figure 2



Elevation of small bowel via traumatic graspers, with twisting to inspect both aspects of bowel wall and mesentery.

Mann–Whitney test was used to compare the two groups. Qualitative data were presented as number and percentage and compared using either χ^2 test or Fisher's exact test. Graphs were produced by using Excel or STATA program. *P* value was considered significant if it was less than 0.05.

Ethical consideration

A written informed consent was taken from all participating patients or their legal guardians. Ethical approval was obtained from the medical research ethics committee under IBR Registration number: S20-157.

Results

This was a prospective study of 50 patients aged from 20 to 65 years, hemodynamically stable, had IBAT who underwent diagnostic and/or therapeutic laparoscopy at the Emergency Department of Sohag University Hospital. Sociodemographic data regarding age, sex, etc. are demonstrated in Table 1.

Regarding the mechanisms of injury, the commonest causes of BAT were road traffic accident (24%) followed by fall from height (20%), motorcycle accident and physical assault (abdominal blow) (16% for each), pedestrian accidents (12%), bicycle accident (8%), and sports accident (4%), as shown in Table 2.

Table 1 Sociodemographic data of studied population

Variables	Summary statistics [*n* (%)]
Age (year)	
Mean±SD	42.0±13.5
Mean (range)	43 (20–65)
Sex	
Female	14 (28.00)
Male	36 (72.00)
Social status	
Married	30 (60.00)
Single	12 (24.00)
Widow	4 (8.00)
Divorced	4 (8.00)
Occupation	
Farmer	14 (28.00)
Employer	8 (16.00)
Student	8 (16.00)
Worker	8 (16.00)
Housewife	6 (12.00)
Teacher	6 (12.00)
Special habit	
Cigarette smoker	18 (36.00)
Goza	16 (32.00)
Others	12 (24.00)

Regarding anatomical sites affected by BAT, the most common affected site was the umbilical region (48%), left hypochondrial region (36%), right hypochondrial region, and hypogastric region (24% for each), as shown in Table 3.

From noon to 6 p.m. was the commonest period for occurrence of trauma (52%), then the period from 6 a.m.–noon (24%), the period from 6 p.m. to midnight (16%), and lastly, the period from midnight to 6 a.m. (8%), as shown in Table 4.

Preoperative radiological finding were as follows: 10 (20%) patients showed air under the diaphragm in chest radiograph, as shown in Fig. 3. Abdominal plain radiograph in erect position shows air under the diaphragm in 10 (20%) patients. Pelvi-abdominal US (FAST) was positive in 38 (76%) patients in detection of hemoperitoneum, hemopneumoperitoneum, and organ injuries (spleen, liver, and gall bladder), as shown in Figs 4–6. As pelvi-abdominal CT was positive in 44 (88%) patients, thus it was more accurate than pelvi-abdominal US (FAST) in detection of hemoperitoneum,

Table 2 Mechanisms of injury

Variables	*n* (%)
Road traffic accident	12 (24.00)
Motorcycle accident	8 (16.00)
Bicycle accident	4 (8.00)
Pedestrian	6 (12.00)
Fall from height	10 (20.00)
Physical assault	8 (16.00)
Sport accident	2 (4.00)

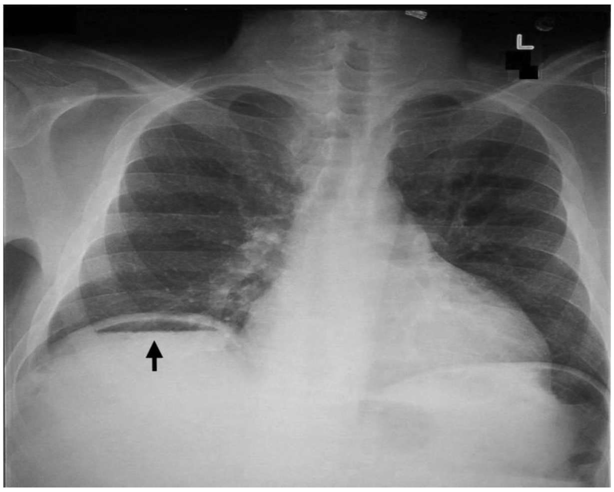
Table 3 Anatomical sites affected

Variables	*n* (%)
Right hypochondrial region	12 (24.00)
Left hypochondrial region	18 (36.00)
Epigastric region	14 (28.00)
Right lumber region	8 (16.00)
Left lumber region	10 (20.00)
Umbilical region	24 (48.00)
Right iliac fossa region	8 (16.00)
Left iliac fossa region	6 (12.00)
Hypogastric region	12 (24.00)
Physical signs in other parts of the body	
No	50 (100)

Table 4 Time of trauma

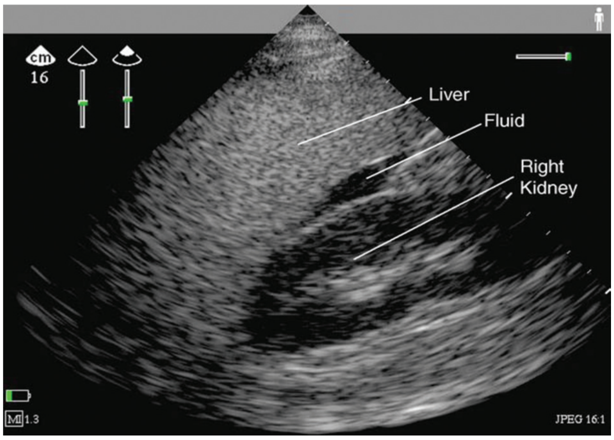
Variables	*n* (%)
6 a.m.–noon	12 (24.00)
Noon–6 p.m.	26 (52.00)
6 p.m. to midnight	8 (16.00)
Midnight to 6 a.m.	4 (8.00)

Figure 3



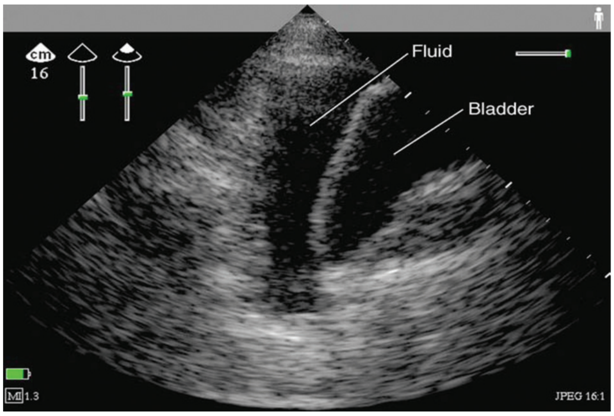
Chest radiograph showing pneumoperitoneum (gas under the diaphragm) owing to traumatic perforated viscous.

Figure 4



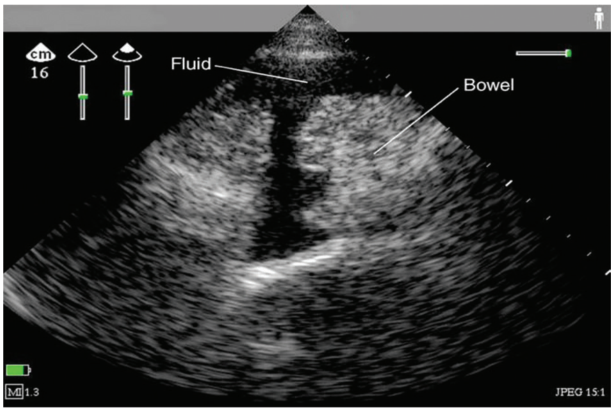
Free fluid in hepatorenal interface.

Figure 5



Longitudinal pelvic view with intraperitoneal fluid seen outside of the bladder.

Figure 6



Fluid in pericolic gutter. Note floating bowel loops.

Figure 7

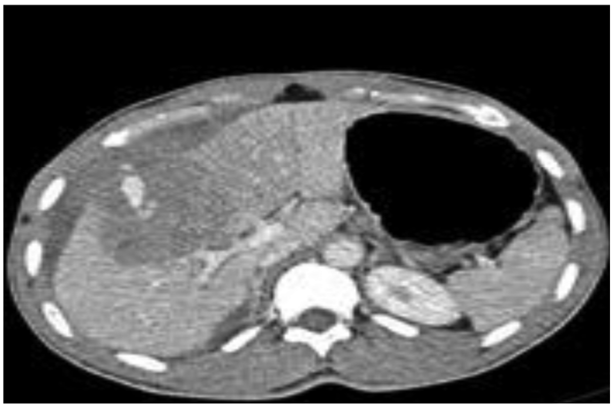
Contrast-enhanced CT scan: small splenic laceration that does not involve the hilum with free fluid surrounding the spleen. CT, computed tomography.

hemopneumoperitoneum, and organ injuries (spleen, liver, and gall bladder), as shown in Figs 7–9 and Table 5.

The commonest affected organ in BAT in this research was the spleen in 18 (36%) patients, followed by the liver in 10 (20%) patients, mesentery in six (12%) patients, small intestine, colon, and gall bladder in four (8%) patients each, and lastly, the stomach in two (4%) patients. Moreover, there were no affected organs (negative laparoscopic exploration) in two (4%) patients. Conversion to laparotomy was done in 18 cases (severely damaged spleen, liver, small intestinal, colon, and stomach injuries were the causes of conversion), as shown in Table 6 and Fig. 10.

The duration of operative time of cases that completed laparoscopically (nonconverted) ranged from 35 to 110 min. The duration of laparoscopic abdominal exploration before decision to conversion ranged from 28 to 40 min. So, the duration of laparoscopic management was highly significantly increased in

Figure 8



Grade IV liver laceration.

Figure 9

Traumatic perforation of jejunum (thickening of the wall and fluid collection surrounding bowel loops).

Table 5 Preoperative radiological findings

Variables	Summary
Chest radiograph	
Negative	40 (80.00)
Positive	10 (20.00)
Erect radiograph abdomen	
Negative	40 (80.00)
Positive	10 (20.00)
Pelvi-abdominal ultrasonography (FAST)	
Negative	12 (24.00)
Positive	38 (76.00)
Pelvi-abdominal CT	
Negative	6 (12.00)
Positive	44 (88.00)

CT, computed tomography; FAST, Focused Assessment with Sonography in Trauma.

Table 6 Injured organs

	Converted (*N*=18)	Nonconverted (*N*=32)	*P* value
No injured organ	0	2 (6.3)	0.53
Spleen	6 (33.3)	12 (37.5)	0.77
Liver	2 (11.1)	8 (25.0)	0.30
Small intestine	4 (22.2)	0	0.01
Colon	4 (22.2)	0	0.01
Mesentery	0	6 (18.8)	0.08
Stomach	2 (11.1)	0	0.13
Gall bladder	0	4 (12.50)	0.28

nonconverted cases in comparison with converted cases (*P*? 0.0001), as shown in Table 7 and Fig. 11.

Postoperative pain according to VAP was less in cases completed laparoscopically than those cases converted to laparotomy within 48 h postoperatively. Pain was highly significantly increased in converted cases in comparison with nonconverted cases (*P*= 0.0001), as shown in Table 8 and Fig. 12. Pain was controlled by intramuscular NSAIDs and replaced by oral NSAIDs on resuming oral intake.

Regarding duration of hospital stay, it was highly significantly increased in converted cases in comparison with nonconverted cases (*P*= 0.0001), as shown in Table 9 and Fig. 13.

Regarding postoperative complications, wound infection, wound hematoma, intraabdominal hemorrhage, wound dehiscence, and reexploration were significantly increased in converted cases in comparison with nonconverted cases (*P*=0.002, 0.01, 0.01, 0.01, and 0.001, respectively), as shown in Table 10 and Fig. 14.

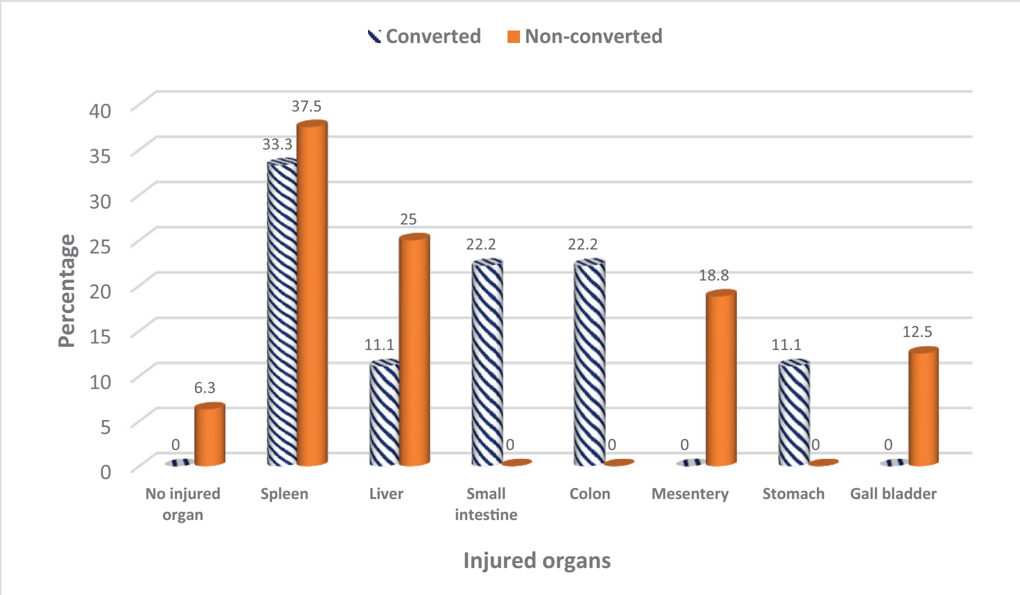
Regarding operative techniques, splenectomy, resection anastomosis, and colostomy were significantly increased in converted cases in comparison with nonconverted cases (*P*=0.001, 0.01, and 0.01, respectively), whereas splenorrhaphy was significantly increased in nonconverted cases in comparison with converted cases (*P*=0.002), as shown in Table 11 and Figs 15–22.

Discussion

In our study, patients' age ranged from 20 to 65 years, with mean±SD of 42.0±13.5 years. In other studies, patients' age ranged from 18 to 60 years, with mean ±SD of 37.93±10.7 [12].

Other studies reported that the incidence of males was more than females (55 and 45%, respectively) in BAT [12]. This concurs with our results, where the incidence of males was more than females (72 and 28%, respectively) in BAT.

Figure 10



Injured organs.

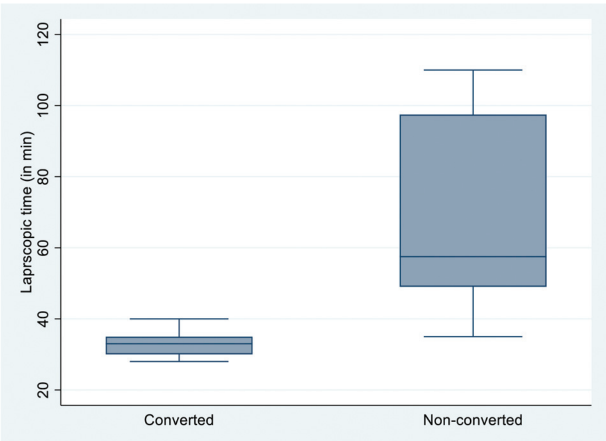
Table 7 Duration of laparoscopic management (in minutes)

Duration of laparoscopic management	Converted (*N*=18)	Nonconverted (*N*=32)	*P* value
Mean±SD	33.1±3.5	69.7±25.3	<0.0001
Mean (range)	33 (28–40)	57.5 (35–110)	

Table 9 Hospital stay (day)

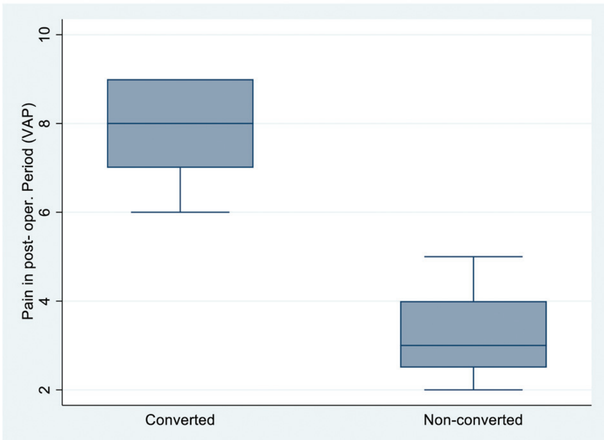
Hospital stay	Converted (*N*=18)	Nonconverted (*N*=32)	*P* value
Mean±SD	9.8±2.0	2.9±1.2	<0.0001
Mean (range)	10 (6–13)	2.5 (2–6)	

Figure 11



Duration of laparoscopic management (in minutes).

Figure 12



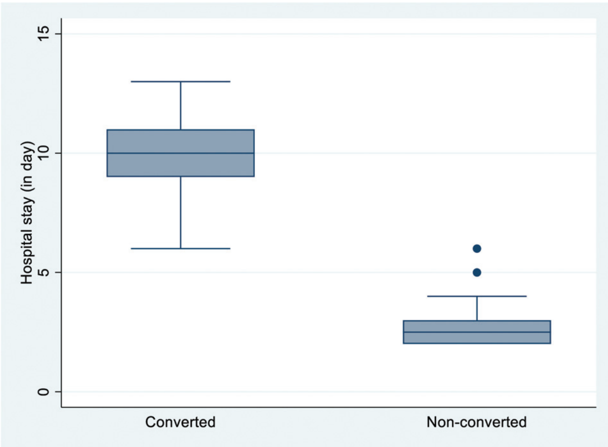
Pain score in postoperative period (VAP). VAP, visual analog scale of pain.

Table 8 Pain score in postoperative period (visual analog scale of pain)

Pain score	Converted (*N*=18)	Nonconverted (*N*=32)	*P* value
Mean±SD	8±1.1	3.2±1.0	<0.0001
Mean (range)	8 (6–9)	3 (2–5)	

Regarding the mechanisms of injury, Al-Ayoubi *et al.* [13] reported that fall from height was the commonest mechanism, representing 126 of 256 patients, followed by traffic accident. Other researchers found that the commonest mechanisms of BAT are road traffic accidents followed by pedestrian accidents, fall from heights, and abdominal blows [12]. Vehicle accidents

Figure 13



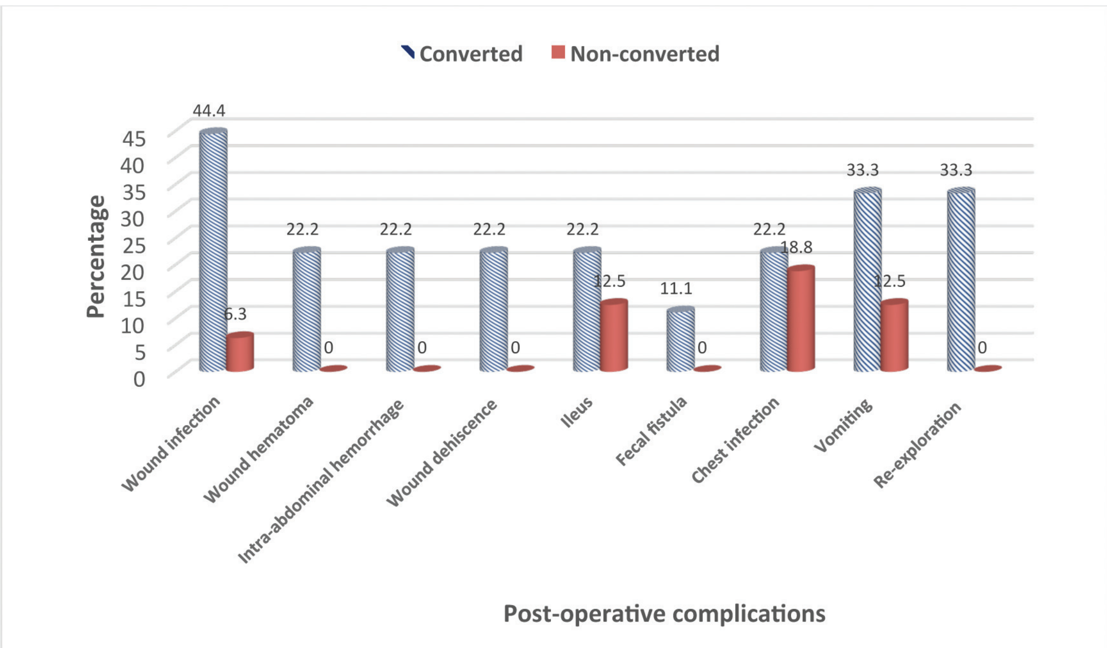
Hospital stay (day).

were a common cause of BAT [14]. Moreover, others reported that in civilian life, the majority of abdominal injuries were owing to trauma secondary to high–speed automobile accidents [15]. Among most patients with BAT caused by road traffic accidents and having multiple associated injuries, prompt diagnosis of all injuries is difficult, and a delay in management may result in the higher rate of complications (25–65%) [16]. In our study, we observed that the commonest causes of BAT were motor car accident (24%) followed by fall from height (20%), motorcycle accident and physical assault (abdominal blow) (16% for each), pedestrian accidents (12%), bicycle accident (8%), and sports accident (4%). The predominance of traffic accidents may be related to adoption of less cautious attitude in traffic, overcrowding of roads, and

Table 10 Postoperative complications and outcome

	Converted (*N*=18)	Nonconverted (*N*=32)	*P* value
Wound infection	8 (44.4)	2 (6.3)	0.002
Wound hematoma	4 (22.2)	0	0.01
Intraabdominal hemorrhage	4 (22.2)	0	0.01
Wound dehiscence	4 (22.2)	0	0.01
Ileus	4 (22.2)	4 (12.5)	0.44
Fecal fistula	2 (11.1)	0	0.13
Chest infection	4 (22.2)	6 (18.8)	1.00
Vomiting	6 (33.3)	4 (12.5)	0.14
Re-exploration	6 (33.3)	0	0.001
Outcome			
Living	18 (100)	32 (100)	

Figure 14

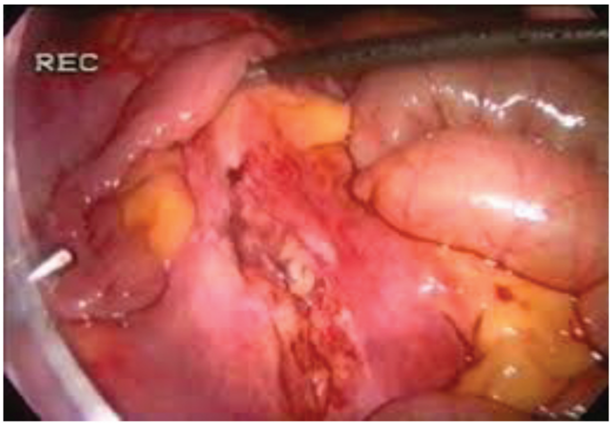


Postoperative complications and outcome.

Table 11 Operative techniques

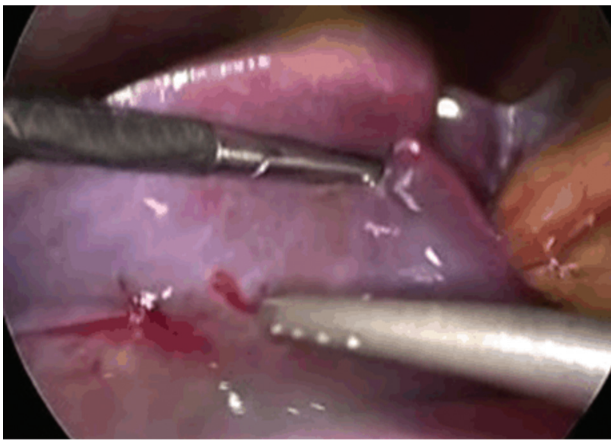
	Converted (*N*=18)	Nonconverted (*N*=32)	*P* value
Repair of injured organ	6 (33.3)	8 (25.0)	0.53
Splenectomy	6 (33.3)	0	0.001
Cholecystectomy	0	4 (12.5)	0.28
Repair of mesentery	0	6 (18.8)	0.08
Resection anastomosis	4 (22.2)	0	0.01
Colostomy	4 (22.2)	0	0.01
Clipping of bleeding vessels	0	6 (18.8)	0.08
Packing of injured organ	2 (11.1)	0	0.13
Splenorrhaphy	0	12 (37.5)	0.002

Figure 15



Mesenteric laceration in a case of blunt abdominal trauma treated laparoscopically.

Figure 16

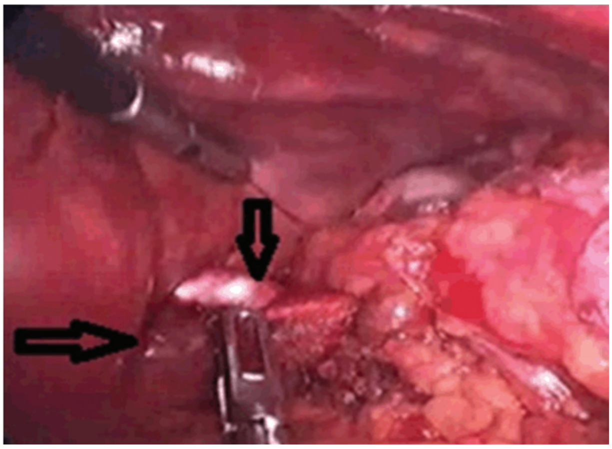


Liver laceration treated laparoscopically (cauterization and Surgicel).

bad roads and bridges network, and also a positive association between external events and the consumption of psychoactive substances.

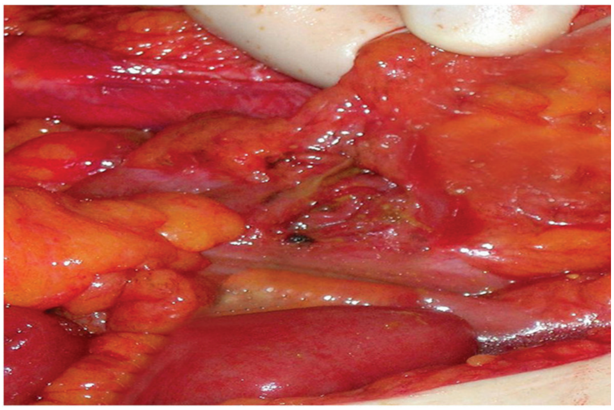
Regarding anatomical sites affected by BAT, other researchers observed that the upper abdomen was the most affected area [5]. In our study, the most affected site was the umbilical region (48%), then left hypochondrial region (36%), right hypochondrial region, and hypogastric region (24% for each).

Figure 17



Laparoscopic hemostasis by Surgicel.

Figure 18



Sigmoid colon injury caused by BAT treated by colostomy. BAT, blunt abdominal trauma.

Others found that the traumatic injuries occurred more frequently at night time and evening [17]. In our study, from noon–6 p.m. was the commonest period for occurrence of trauma (52%), then the period from 6

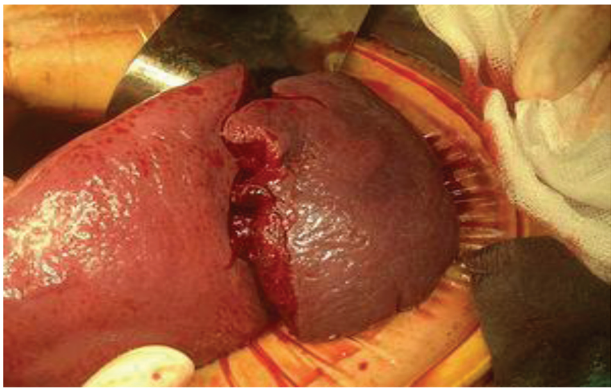
Figure 19

Traumatic perforation of small intestine caused by BAT. BAT, blunt abdominal trauma.

Figure 20

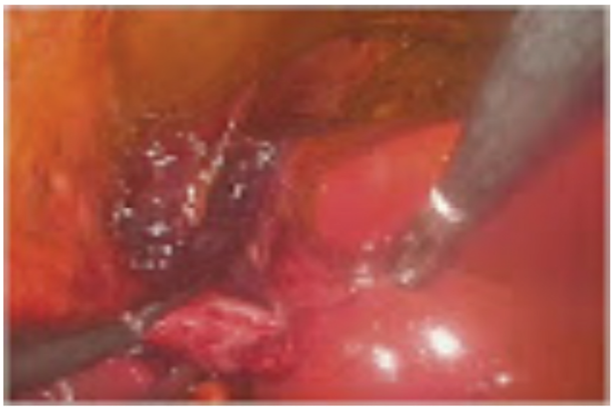
Stapling treatment of traumatic perforated small bowel.

Figure 21



Severely injured spleen by BAT and treated by open splenectomy. BAT, blunt abdominal trauma.

Figure 22



Rupture of the liver parenchyma caused by severe BAT. BAT, blunt abdominal trauma.

a.m.–noon (24%), the period from 6 p.m. to midnight (16%), and lastly, the period from midnight to 6 a.m. (8%).

Regarding the preoperative radiological finding, other investigators, reported that the FAST is noninvasive bedside imaging modality to identify free fluid in the abdominal cavity; however, it is highly operator dependent. It is usually used as an adjunct to the primary survey according to the ATLS guidelines. However, Dolich *et al.* [18] found that organ injuries were negative in 1.7% of patients with FAST, and 23% of them required exploratory laparotomy. Authors in recent studies from United States discovered that FAST sensitivity in stable patients with BAT was 22%, and they proposed, when possible, to bypass FAST examination and go directly to CT scan [19]. Other researchers found that the main goal of FAST is to detect the presence of free fluid but cannot determine the source and may not detect retroperitoneal, hollow viscous, or injured solid organs without hemoperitoneum [20]. Despite their many positive qualities, all diagnostic methods have some drawbacks. There has been increasing interest in the use of abdominal US because it is portable, noninvasive, easily repeatable, and rapid. FAST examination is rapidly becoming an accepted practice in many trauma centers. The FAST procedure surveys for blood in the pericardial sac and intra-abdominal fluid collection in Morison's pouch, the splenorenal recess, bilateral subphrenic space, bilateral paracolic gutter, and Douglas cul de sac. It is completed in ~2.5 min. However, it definitely is an operator-dependent test, and it is less accurate in diagnosis of hollow viscous and diaphragmatic injuries [21]. In our study, we observed that pelvi-abdominal US (FAST) was positive in 38 (76%) patients in detection of hemoperitoneum, hemopneumoperitoneum, and organ injuries (spleen, liver, and gall bladder) and negative in 12 (24%) patients.

Regarding pelvi-abdominal CT, Banz *et al.* [22] stated that CT exhibits very high sensitivity and specificity in detecting the majority of solid organ injuries, but unfortunately misses up to 15% of mesenteric and small bowel injuries as well as some acute pancreatic injuries. Lee *et al.* [23] considered CT was the definitive technique because of its high sensitivity and specificity in injury detection, localization, and grading. However, clinically unstable patients are not an option for CT because they cannot sustain travel to the CT scanner, and also pregnant women and who will not fit in the scanner due to their body habitus. Sonography has some specific advantages over CT because it is a bedside examination, uses nonionizing radiation, and provides relatively expedient examination. Furthermore, there are no required contrast agents for patients undergoing sonography; thus, they are spared the associated risk of contrast reaction and nephrotoxicity [23]. Lin *et al.* [10] reported that in hollow viscous injuries, high rates of false-negative results (44.7–54.5%) have been recorded. In this current study, we reported that pelvi-abdominal CT was positive in 44 (88%) patients; thus, it is more accurate than pelvi-abdominal US (FAST) in detection of hemoperitoneum, hemopneumoperitoneum, and organ injuries (splenic, liver, and gall bladder) and negative in six (12%) patients.

Regarding the duration of laparoscopic management (in minutes), other studies showed significant increase in the duration of laparoscopic management (in minutes) in nonconverted cases (range, 20–125 min) in comparison with converted cases (laparoscopic time) (range, 25–35 min) [12]. This concurs with our results, where the duration of laparoscopic management was highly significantly increased (P= 0.0001) in nonconverted (range, 35–110 min) in comparison with converted cases (range, 28–40 min).

Other studies reported that BAT shows conversion rate up to 23%, which was higher than the PAT, which shows conversion rate up to 11.7% [24]. The higher conversion rate for blunt trauma reflects the severity and multiplicity of intra-abdominal injuries. In literature, depending on the selection criteria, the conversion rate varies from 8.5 to 37% [25]. The causes for conversion were multiple complex injuries, bleeding, visualization problem, and equipment failure; moreover, the respiratory and hemodynamic deterioration of patient should lead to conversion [24]. In our results, 18 (36%) cases were converted to laparotomy owing to noncontrolled or severely damaged spleen, liver, small intestine, colon, and stomach.

Others found that 40 hemodynamically stable patients experiencing BAT underwent diagnostic laparoscopy. Five patients were negative, whereas 13 patients were converted to conventional open exploration. Most of the converted cases were small intestine and splenic injuries [12]. Johnson *et al.* [26] reported that over the 10-year study period, 22 patients with blunt trauma underwent diagnostic laparoscopy. Laparoscopy was negative in four (18.2%) patients and nontherapeutic in 15 (68.2%) patients. Three (13.6%) patients required conversion to an open procedure [26]. In this current study, 50 hemodynamically stable patients with BAT underwent diagnostic laparoscopy. Overall, two (4%) patients were negative, whereas 18 (36%) patients were converted to conventional open exploration. Most of the converted cases had severely damaged spleen, liver, small bowel, colon, and stomach injuries. However, 30 (60%) patients underwent therapeutic laparoscopy.

In other studies, the most common injuries were small bowel and mesenteric injuries [27]. Other investigators found that when evaluating BAT the spleen was the most affected organ, followed by the liver and pancreas [28]. Moreover, others observed that the small bowel and spleen were the most frequent affected organs, in both penetrating and blunt traumas [29]. In this current study, the commonest affected organ was the spleen in 18 (36%) patients, then the liver in 10 (20%) patients, mesentery in six (12%) patients, small intestine, colon, and gall bladder in four (8%) patients each, and lastly, the stomach in two (4%) patients; moreover, there were no affected organs (negative laparoscopic exploration) in two (4%) patients. A total of 18 cases were converted to open repair owing to noncontrolled or severely damaged spleen, liver, small intestine, colon, and stomach.

Regarding postoperative pain according to VAP, other studies observed that postoperative pain was less in cases completed laparoscopically, which is statistically significant. Pain was controlled by intramuscular diclofenac sodium and replaced by oral ketofen on resuming oral intake [12]. This concurs with our results, where pain (VAP) in converted cases was highly significantly increased in comparison with nonconverted cases (P= 0.0001). Pain was controlled by intramuscular NSAIDs and replaced by oral NSAIDs on resuming oral intake.

Regarding the period of hospital stay, Johnson *et al.* [26] reported that the mean length of hospital stay, for patients with blunt injuries was 9 days for the laparoscopy group compared with 20 days for those requiring laparotomy. Lin *et al*. [10] reported that after laparoscopy, the mean hospital stay was 11.0 days as compared with 17.6 days ($P<0.001$) after laparotomy. This concurs with our study, where hospital stay was significantly increased in converted (laparotomy) cases (range, 6–13 days) in comparison with nonconverted (completed laparoscopically) cases (range, 2–6 days) (*P*? 0.001).

Regarding postoperative complications, all recorded complications have been reported to be more frequently with open laparotomy than in laparoscopic surgery [12]. This concurs with our results, in which wound infection, wound hematoma, intra-abdominal hemorrhage, wound dehiscence, and re-exploration were significantly increased in converted cases in comparison with nonconverted cases (P=0.002, 0.01, 0.01, 0.01, and 0.001, respectively).

Regarding operative techniques, splenectomy, resection anastomosis, and colostomy were significantly increased in converted cases in comparison with nonconverted cases (P=0.001, 0.01, and 0.01, respectively), whereas splenorrhaphy was significantly increased in nonconverted cases in comparison with converted cases (P=0.002).

Conclusion

Laparoscopy in BAT is safe, accurate, and feasible. In advanced laparoscopy, the prerequisites are the hemodynamic stability of the patient and surgical expertise. The most important advantages of laparoscopy on laparotomy are reduction of nontherapeutic laparotomy rate, duration of operative period, postoperative pain, postoperative complications, and shortening of duration of hospital stay.

Recommendation

(1) Laparoscopic management of BAT needs increasing its learning curve for optimum results.
(2) Rapid emergency transport of victims and rapid intervention should help to reduce the mortality and morbidity associated with BAT.

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Conflicts of interest

There are no conflicts of interest.

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