# Blunt abdominal trauma requiring laparotomy in poly-traumatized patients

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## ABSTRACT

**الأهداف**: اكتشاف تأثير الإصابات خارج البطن على معدل المرض و الوفاة فى المرضى متعددى الإصابات ذوى الإصابات البطنية الغير نافذه.

**الطريقه**: شمل هذا التحليل المرضى متعددوا الصدمات الذين يعانون من إصابة غير نافذه بالبطن والذين تم علاجهم في وحدات الطوارىء في مستشفى جامعة المنيا ومستشفي جامعة مصرللعلوم والتكنولوجيا بين مارس 2006 ومارس 2008. وتتراوح أعمارالمرضى بين 4 و 73 عام بمعدل شدة إصابة أكثر من 18 نقطه وتشير إلى التدخل الجراحي، وتم تحليل بياناتهم من خلال تفاصيل الإصابة و العلاج، والمضاعفات، ومعدل الوفيات.

**النتائج**: تطابقت حالة 94 مريض مع المعايير بمعدل ISS 29.3 ±6.4، و كانت أكثر الإصابات تكرارا بالطحال (61.7%) والكبد (47.9%)، و مثلت إصابات الصدر أكثر الإصابات الغير بطنية شيوعاً 67%. توفي 36 مريض (38.3%) أثناء وجودهم بالمستشفى، و كانت أكثر الأسباب شيوعا للوفاه الصدمةَ النزفيةَ (27.8%)، ثم متلازمة ضيق التنفس الحادة 27.8%، ثم إصابات الرأس (22.2%). كانت هناك علاقة إيجابية بين إصابات الكبد و معدل الوفاة فى هؤلاء المرضى، ولم يتبين وجود ذلك في إصابات الطحال. الوفيات كان أكثرها سببه الإصابات الغير البطنية (66.7%)، ثم إصابات البطن الداخلية(19.4%)، ثم كلاهما متحدين في 5 مرضى (13.9%).

**خاتمه**: الإصابات الغير بطنية تضيف إلى معدل المضاعفات والوفاة فى حالات الإصابات البطنية الغير نافذه في المرضى متعددى الإصابات. من الممكن اَن يقلل استخدام الأشعة المقطعية من الإستكشاف السلبي للبطن ويعطى فرصةً للمعالجة بشكل أكبر للإصابات الغير بطنية في المرضى متعددى الاصابات.

**Objectives:** To investigate the impact of associated extra-abdominal injury on morbidity and mortality in poly-traumatized patients with blunt abdominal trauma.

**Methods:** This analysis included poly-traumatized patients with blunt abdominal trauma treated at the Emergency Unit of Minia University Hospital and Misr University for Science and Technology Hospital, Minia, Egypt, between March 2006 and March 2008. This study included patients aged 4-73 years with injury severity score (ISS) more than 18 and indicated for surgical intervention. Data were analyzed with details of injury, treatment, complications, and mortality.

**Results:** Inclusion criteria were met by 94 patients with mean ISS of 29.3 ± 6.4. Most frequent injuries were seen in the spleen (61.7%) and liver (47.9%). Chest trauma represents most common extra-abdominal trauma (67%). Thirty-six patients (38.3%) died during their hospital stay. Most frequent reasons for death were hemorrhagic shock (27.8%), acute respiratory distress syndrome (27.8%), and head trauma (22.2%). There was a positive relationship between liver injury and mortality, which was not found in splenic injuries. Significantly more deaths were attributed to primarily extra-abdominal injuries (66.7%) and then to intra-abdominal injuries (19.4%). In 5 patients (13.9%), a combination of intra- and extra-abdominal injuries caused post-traumatic death.

**Conclusion:** Extra-abdominal injuries add to the morbidity and mortality from blunt abdominal trauma in poly-traumatized patients. Routine computerized tomography scanning can minimize negative abdominal exploration and facilitate better management of extra-abdominal injuries.

Abdominal trauma is an important issue as it represents a leading cause of death in different age groups. Delays in making correct treatment decisions could be life-threatening,[1] therefore, rapid assessment and appropriate treatment of potentially life-threatening conditions are essential. There is no problem with management protocols of hemodynamically unstable

patients with blunt abdominal trauma who require urgent laparotomy, but the controversy is still present regarding hemodynamically stable patients.[2] During the 1970's a positive diagnostic peritoneal lavage was considered as an absolute indication for surgery, but this tool gives up to 39% false positive results.[3] Computerized tomography (CT) played a role also as diagnostic tool for intra-abdominal injuries in the 1970's, but it was time-consuming and usually required transport of the patient from the emergency unit to radiology unit.[4] However, the use of imaging tools such as CT and ultrasonography improves visualization of abdominal organs and sometimes precise grading of organ injuries.[5] The clinical outcome following non-operative management of liver injuries in hemodynamically stable patients improves, regardless of the grade of injury.[6] In splenic injuries, non-operative management was shown to result in increased survival.[7] Therefore, non-operative treatment of abdominal solid organ injuries has become the standard management.[8] However, presence of other co-morbidities may restrict the conservative management to certain cases.[6] Assessments of diagnostic tools,[5] complications of abdominal injuries,[9] and requirement for surgical interference[10] were discussed in several studies. In the literature, initial abdominal examination following blunt trauma is unreliable.[4] Also, the clinical course and management of combined extra- and intra-abdominal trauma still needs further study.[11] The poly-traumatized patient with hemodynamic instability may have negative exploration as volume loss was due to an extra-abdominal cause,[3] at the same time management of intra-abdominal injury may be delayed or missed in the poly-traumatized patient leading to high mortality.[12] Therefore, abdominal injuries should be managed as early as possible.[2]

The aim of this study was to find out the impact of associated extra-abdominal injury on morbidity and mortality in poly-traumatized patients with blunt abdominal trauma.

**Methods.** One hundred and four poly-traumatized patients with blunt abdominal trauma, who had or who were suspected of having an intra-abdominal injury were treated at the Emergency Unit of 2 university hospitals (Minia University Hospital and Misr University for Science and Technology Hospital), in Minia, Egypt between March 2006 and March 2008. The patients were 4-73 years of age (average 32 years). There were 71 males and 33 females. All victims reached the hospital within 2-3 hours after the accident. Patients aged 4-73 years with injury severity score (ISS) more than 18 and indicated for surgical intervention were included. Data were analyzed with details of injury, treatment, complications, and mortality. This study excluded those with penetrating abdominal injury

and those with negative abdominal exploration. We followed Baker's criteria[13] to classify abbreviated injury severity (AIS): AIS 1 = minor, AIS 2 = moderate, AIS 3 = serious but not life threatening, AIS 4 = severer, life threatening, survival probable, AIS 5 - critical, survival uncertain, AIS 6 = virtually unsurvivable (calculated as the sum of squares of the highest AIS severity codes of 3 worst injured body regions), and the degree of head injury was classified according to Taesdale et al study.[15] The American Association for the Surgery of Trauma (AAST) definitions were used to grade abdominal organ injuries[16] while Moore et al's[17] classification was used to grade splenic injury. At the time of admission, cardio-vascular and pulmonary stabilization were performed using mechanical ventilation, central venous pressure monitoring, and invasive arterial pressure monitoring. Intravenous infusion is usually achieved via wide bore peripheral access. Every patient underwent full clinical examination, plain x-ray, ultrasonography, and CT before mobilization to the surgical intensive care unit, where another abdominal ultrasound was performed. Indications for laparotomy included: hemodynamic instability with continued fluid infusion in the presence of free abdominal collection, and clinical signs of peritoneal affection in addition to CT finding of abdominal organ injury. Minor splenic and hepatic injuries (grades I-IV) were treated by bipolar coagulation or gelfoam patches. Splenectomy (whether partial or complete) and liver resection were performed for severe splenic and hepatic injuries; otherwise, a damage control approach was performed for re-operation. Major fractures were stabilized acutely either by internal or external fixation utilizing a damage control approach for unstable patients. Patients who were in a critical condition due to associated injuries usually underwent laparotomy or craniotomy prior to fracture management, which may be managed by an external fixator at the same time in highly unstable patients.

Proportions and percentages were used to summarize categorized variables, while descriptive statistics such as mean±SD were used for numerical values. The $x^2$ test was used to investigate the statistical significance of any categorical values. The probability value was considered significant if ≤0.05. During the study period, we used the Statistical Package Version 10.0 (SPSS Inc, Chicago, III) for windows (Microsoft Corporation, Redmond, Washington, USA).

**Results.** Of 104 cases, 5 patients who sustained a penetrating injury and 3 patients with negative findings at laparotomy were excluded. Two patients had an ISS <18 leaving 94 patients for final evaluation. They were 64 male and 30 female patients. The mean ISS was 29.3 ± 6.4. The mean rescue time (trauma to arrival at hospital) was 98.5 ± 19.1 min. The mean

**Table 1** - Injury distribution and severity determined by abbreviated injury scale (AIS) and injury severity score (ISS).

| Injury distribution | AIS of body regions |
|---|---|
| AIS head | 2.4 ± 1.6 |
| AIS face | 0.8 ± 0.5 |
| AIS chest | 3.1 ± 2.4 |
| AIS abdomen | 3.2 ± 0.9 |
| AIS extremities | 4.1 ± 2.3 |
| AIS skin | 1.6 ± 0.9 |
| ISS | 29.3 ± 6.4 |

**Table 2** - Grading of splenic injuries according to established criteria (Moore).[15]

| Injury severity | Number (n) of patients (%) | Mortality (m) m/n (%) | Mortality due to extra-abdominal cause (e) e/m (%) |
|---|---|---|---|
| Class I | 3 (5.2) | 0/3 (0) | 0 (0) |
| Class II | 17 (29.3) | 4/17 (23.5) | 4/4 (100.0) |
| Class III | 14 (24.1) | 4/14 (28.6) | 3/4 (75.0) |
| Class IV | 17 (29.3) | 6/17 (35.3) | 5/6 (83.3) |
| Class V | 7 (12.1) | 3/7 (42.8) | 2/3 (66.7) |

In 13 (22.4%) patients injuries to spleen represented the only abdominal organ injury. There were 2 (3.4%) cases of splenic rupture, all requiring splenectomy

**Table 3** - Grading of liver injuries according to established criteria (Moore).[17]

| Injury severity | Number (n) of patients (%) | Mortality (m) m/n (%) | Mortality due to extra-abdominal cause (e) e/m (%) |
|---|---|---|---|
| Class I | 4 (8.9) | 1/4 (25.0) | 1/1 (100) |
| Class II | 23 (51.1) | 8/23 (34.8) | 8/8 (100) |
| Class III | 11 (24.4) | 5/11 (45.4) | 4/5 (80) |
| Class IV | 3 (6.7) | 2/3 (66.7) | 1/2 (50) |
| Class V | 4 (8.9) | 3/4 (75.0) | 1/3 (33.3) |
| Class VI | 0 (0) | 0 (0) | 0 (0) |

In 6 patients (13.3%) injuries to liver represented the only abdominal organ injury
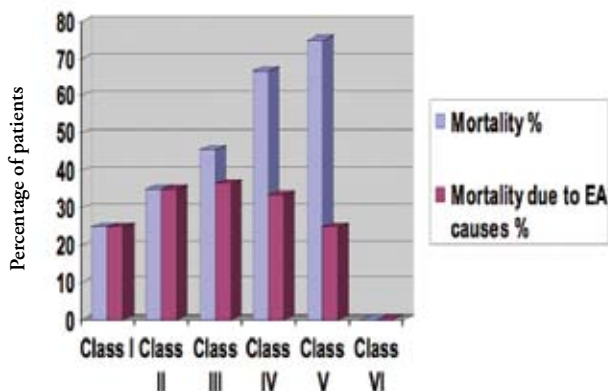


**Figure 1** - Grading of liver injuries as percentage of total patients in each class.

delay prior to surgery was 90.3 ± 16.1 min. Delay of 6 hours in 12 patients results in splenic rupture, 8 of them indicating splenectomy. **Table 1** shows the injury distribution and severity score according to AIS and ISS. The most frequently observed injuries were to the spleen (58 injuries; 61.7%), liver (45 injuries; 47.9%), and mesentery (25 injuries; 26.6%). Colonic injuries were seen in 16 cases (17%), small bowel injuries in 10 (10.6%), and gastric injuries in 3 (3.2%). The most common concomitant extra-abdominal trauma in these patients was chest trauma (63 patients; 67%); the most frequently associated extra-abdominal visceral injury was contusion of the lung (38 patients; 40.4% associated with splenic injuries). Concomitant head injuries were observed in 62 patients (65.9% of the included patients). The most frequently observed intra-abdominal injuries were to the spleen (61.7%) and the liver (47.9%). Grading of splenic and hepatic injuries is shown in **Tables 3 & 4** and **Figure 1**. Class II and class IV injuries were the most common splenic injuries. In 52.9% of class II injuries, the spleen was preserved, whereas 100% of class IV injuries were treated by complete splenectomy. More than half of the liver injuries were classified as class II injuries; 78.3% of these injuries were treated by coagulation. Overall, in splenic injuries the most frequent surgical procedure was complete splenectomy, whereas coagulation was most frequently performed in liver injuries (**Tables 5 & 6**). Seven of 25 mesenteric injuries were minor and did not require further intervention. Suture repair was performed in 14 cases and a bowel resection was performed in 4 cases. Of 10 patients with small bowel injuries, primary closure was possible in 6 cases and resection and end-to-end anastomosis was required in 3. There was only one duodenal injury, successfully treated

**Table 4** - Treatment of splenic injuries.

| Surgical intervention | Number of patients n (%) | Injury severity |
|---|---|---|
| Organ preserving (coagulation, gelfoam patch) | 12 (20.7) | Class I: 3 Class II: 9 |
| Partial splenectomy | 2 (3.4) | Class II:1 Class III:1 |
| Complete splenectomy | 43 (74.1) | Class II: 7 Class III: 12 Class IV: 17 Class V: 7 |
| Surgery for injury of other abdominal organs | 1 (1.7) | Class III: 1 |

In one patient, no intervention for the splenic injury was performed, but other abdominal injuries were treated. The liver was involved in this case.

with primary suture. Of 3 patients who sustained gastric injuries, primary closure was possible. There were 16 patients with large bowel injuries. Primary closure was possible in 11 cases, resection and end-to-end anastomosis in 5 cases. The delay in the diagnosis of hollow viscus lesions occurred in 3 patients (10.3%). Pancreatic injuries occurred in 6 patients: 4 of these required drainage, and 2 injuries to the pancreatic tail were sutured. Diaphragmatic injury was identified in

**Table 5** - Treatment of liver injuries.

| Surgical intervention | Number of patients (%) | | Injury severity |
|---|---|---|---|
| Coagulation | 26 | (57.8) | Class I: 2 |
| | | | Class II: 18 |
| | | | Class III: 6 |
| Segmental resection | 3 | (6.7) | Class IV: 1 |
| | | | Class V: 2 |
| Packing | 11 | (24.4) | Class II: 3 |
| | | | Class III: 4 |
| | | | Class IV: 2 |
| | | | Class V: 2 |
| Surgery for injury of other abdominal organs | 5 | (11.1) | Class I: 2 |
| | | | Class II: 2 |
| | | | Class III: 1 |

In 5 patients, no intervention for the liver injury was performed, but other intra-abdominal injuries were treated. These involved the spleen in all cases.

**Table 6** - Complications and causes of death, differentiated by early and late mortality.

| Cause of death | Number of patients | | Early mortality | | Late mortality | |
|---|---|---|---|---|---|---|
| | n | (%) | n | (%) | n | (%) |
| Head trauma | 8 | (22.2) | 4 | (50.0) | 4 | (50) |
| Hemorrhagic shock | 10 | (27.8) | 10 | (100) | 0 | 0 |
| ARDS | 10 | (27.8) | 0 | | 10 | (100) |
| Sepsis | 4 | (11.1) | 0 | | 4 | (100) |
| MODS | 3 | (8.3) | 0 | | 3 | (100) |
| Pulmonary embolism | 1 | (2.8) | 0 | | 1 | (100) |
| **Total** | **36** | **(100)** | **14** | **(38.9)** | **22** | **(61.1)** |

ARDS - acute respiratory distress syndrome,
MODS - multiple organ dysfunction syndrome

**Table 7** - Early and late mortality and its association to intra- and extra-abdominal injuries.

| Causes of death | Number of deaths (n=36) | | Number of early deaths (n=14) | | Number of late deaths (n=22) | |
|---|---|---|---|---|---|---|
| | n | (%) | n | (%) | n | (%) |
| Extra-abdominal | 24 | (66.7) | 8 | (33.3) | 16 | (66.7) |
| Intra-abdominal | 7 | (19.4) | 3 | (42.9) | 4 | (57.1) |
| *Combination* | 5 | (13.9) | 3 | (60) | 2 | (40) |
| Chest/abdomen | 3 | (8.3) | 2 | (66.7) | 1 | (33.3) |
| Pelvis/abdomen | 2 | (5.6) | 1 | (50) | 1 | (50) |

14 patients and required suture, using an abdominal approach. Treatment for the 16 patients with renal injuries included suture repair in 5 patients, partial resection in 2 patients, and nephrectomy in 9 patients. Three bladder injuries were repaired by primary suture. Treatment for one patient with urethral injury included urethral catheterization. The abdominal aorta was injured in one patient and suture repair was possible in this patient. Two vena cava injuries were successfully treated by suture repair. Twenty-four patients had significant retroperitoneal hematomas. Nineteen retroperitoneal hematomas were treated conservatively (15 due to pelvic fracture and 4 associated with mesenteric injury). The remaining 5 retroperitoneal hematomas were explored, 2 occurred secondary to a renal lesion, one secondary to aortic injury, and 2 secondary to inferior vena cava injury. In 36 of the 94 included patients, death occurred as a result of their injuries. Of these patients, 38.9% (14 patients) died within the first 24 hours after trauma (early mortality), whereas 61.1% of all deaths occurred in the later posttraumatic course (late mortality). The causes of death are described in **Table 6**. Deaths primarily attributable to extra-abdominal injuries were significantly more frequent than to intra-abdominal injuries (*p*=0.002). In 5 patients (13.9%), a combination of intra- and extra-abdominal injuries caused posttraumatic death (**Table 8**). Hepatic or splenic injury was found in every dead patient. Ten patients died of hemorrhagic shock during the initial surgical procedure. Early deaths attributable to intra-abdominal injuries were exclusively caused by hemorrhagic shock and occurred intra-operatively. In 2 of these cases, a combination of liver and injury to IVC was found. Delayed mortality from intra-abdominal injury was mainly due to sepsis and multiple organ dysfunction syndrome (MODS). Hepatic injury was found in every patient that died due to intra-abdominal injury. The mortality rate in patients with splenic trauma was 29.3% (17 patients out of a total of 58). There was no association between the severity of splenic injury and death. The presence or absence of liver trauma was not associated with a statistically significant difference in mortality when compared to the entire study population (liver trauma: 42.2% versus entire population: 38.3%). The impact of liver-induced hemorrhage appeared to be clinically relevant with increasing hepatic injury severity.

**Discussion.** The incidence of blunt abdominal trauma rages from 25-40% in poly-traumatized patients being more than that occurring in isolated abdominal trauma.[3,19] Hemorrhagic shock is a major cause of early mortality following multiple trauma. The

overall mortality rate in this study was 38.3%, which is noticeably higher than previously reported rates of between 4 and 31%.[20,2]

This study study limitation was limited to poly-traumatized patients aged 4-73 years with ISS more than 18 and indicated for surgical intervention with positive intra-abdominal injury, while those with negative exploration were excluded. The ISS score in such poly-traumatized patients might be high leading to high mortality,[7,22] which was also reported by Fernandez et al[23] who found that the mortality rate was higher (42%) with an ISS >35 and lower (19%) with an ISS <35. Also, in a study by Hildebrand et al[2] a mortality rate of 41.8% was found in poly-traumatized patients with ISS >18. This explains the high mortality in our study. The important causes of early mortality after blunt abdominal trauma in poly-traumatized patient was hemorrhagic shock,[2,5,10] severe head injury,[10,24] and increased age.[24] This is in accordance with the early mortality data in our study. Severe head trauma and hemorrhagic shock were the most significant reasons for early mortality accounting for approximately 40% of early deaths in this study, compared to 38.8% in a study by Hildebrand et al.[2] So, early and appropriate management of the poly-traumatized patient with hemorrhage is highly recommended. A study of large group of patients with blunt abdominal trauma demonstrated that chest and pelvic injuries were the most important causes of post-traumatic complications.[25] Other studies attributed the mortality after blunt abdominal trauma in poly-traumatized patients to liver, lung,[22] and head injuries.[10] In line with this study, Hildebrand et al[2] reported that poly-trauma will lead to a high incidence of early adverse outcomes. This agrees with our study, which reported that chest, abdomen, and pelvic injuries are responsible for post-traumatic complications. Also, in our study the risk of early mortality was correlated with liver injury in association with extra-abdominal injuries, this correlates with the previous studies.[10,26] The high probability of adverse outcome due to combined liver injuries and chest trauma in our and other studies,[2,22,26] should be taken into account during the early management of poly-traumatized patients. However, the mortality attributed to liver injury in previous studies was variable. In class V injuries, Cogbill et al[27] (80%) and Moore et al[17] (66%) recorded comparable mortality rates to our study, whereas the mortality rates observed by Pachter and Spencer[28] (33.3%) and Mackersie et al[25] (29%) were considerably lower. This difference in the figures of these studies may be due to concentration on isolated liver injury, however, in the present study, only 3% of grade I-III died from their liver injury. So, previous studies showed that post-traumatic complications were dependant on the grade of liver injury and is uncommon in low-grade injuries.[29,30]

Regarding splenic injury, we found that there was no association between grade of splenic trauma and mortality. This coincides with other studies showing that no association between severity of splenic injury and post-traumatic complications.[31,32] Blunt abdominal trauma did not affect the late post-traumatic mortality as the main cause of late mortality in this study was acute respiratory distress syndrome (ARDS). This agrees with Ekkernkamp et al[20] who studied patients with blunt abdominal trauma either isolated or in association with extra-abdominal trauma, approximately 50% of them underwent laparotomy, they found no difference in late mortality between patients with and without abdominal trauma. This also agrees with other studies reporting late post-traumatic mortality due to ARDS,[8] pulmonary embolism,[6] and peri-operative hemorrhage.[23] The rate of sepsis in our series (11.1%) is comparable with a 9% sepsis rate described by Sartorelli et al[8] and 14.9% described by Hildebrand et al.[2] Our results were also comparable with other studies describing the outcome of blunt abdominal trauma.[20,33] Improved outcome may be attributed to increased experience in caring for these patients and in the use of CT scanning and focused abdominal sonography for trauma.[34] Determination of indications of surgery in cases of hemodynamic stability in such patients is still a matter of controversy.[18,34,35] However, increasing non-operative management of solid organ injuries leads to increase in the number of missed hollow viscus injury, as such injuries are detected during surgery for solid organs.[36,37] These injuries, although not life-threatening, increase the incidence of delayed morbidity when initially missed.[18] In the current study, the incidence of sepsis was higher in patients with hollow viscus injury than other organ. So, early detection and dealing with such injuries should be considered to improve outcome.[2] Computerized tomography scan has been reported to be a reliable diagnostic tool with specificity between 94 and 100% and sensitivity between 70 and 95%, which is superior to all other reported diagnostic modalities.[18,36,37] The importance of diagnostic tools in management of abdominal trauma were considered in this study.

In conclusion, severe liver injury in association with extra-abdominal trauma has significantly higher mortality rates in poly-traumatized patients. Hemorrhagic shock was the main cause of early mortality in our study while extra-abdominal injuries and their complications (namely, ARDS) are a major cause of late mortality. So, extra-abdominal injuries add to morbidity and mortality from blunt abdominal trauma in poly-traumatized patients. Routine CT scan of the thorax, abdomen, and pelvis in poly-traumatized patients should be considered to minimize negative abdominal

exploration, and facilitate better management of extra abdominal injuries.

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