Original Research Article

Clinical, sonological and radiographic predictors of abdominal injuries after blunt abdominal trauma

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International Archives of Integrated Medicine, Vol. 5, Issue 4, April, 2018.

Available online at http://iaimjournal.com/
ISSN: 2394-0026 (P) **ISSN: 2394-0034 (O)**
Received on: 05-04-2018 **Accepted on:** 11-04-2018
Source of support: Nil **Conflict of interest:** None declared.
How to cite this article: Peerzada Ziaulhaq, Mohammad Imran Wagay, Sheikh Riaz Rasool, Rouf A Wani, Naseer A Choh, Saba Banday. Clinical, sonological and radiographic predictors of abdominal injuries after blunt abdominal trauma. IAIM, 2018; 5(4): 144-152.

Abstract

There are several situations that complicate the diagnosis of abdominal injuries. Physical examination may be unreliable due to the presence of multiple trauma or changes in the levels of consciousness. This prospective observational study was done consecutive adult blunt abdominal trauma patients. Parameters from pre hospital information, physical examination, laboratory investigations, FAST, and CR were recorded for all patients. Predictors for the presence of ≥1 injuries on abdominal CT were determined. 175 patients were included, with mean ages of 32.94± 14.21 years. 145 had injuries on abdominal CT. Patients with abdominal injuries had significantly lower mean systolic BP on admission (98.79±12.8 v/s 114±7.38), lower mean GCS (11.70±2.02 vs 13.10±1.74), significantly lower levels of hematocrit (29.18±8.31 v/s 34.33±6.46 %); significant difference in presence of abdominal bruises [*p*value ≤ 0.0001,or 6.669 CI (2.42-18.47)]; abdominal tenderness [*p* value ≤ 0.0001, or 63.708 CI (20.171-201.218)] and guarding /rigidity[*p* value ≤ 0.0001, or 5.662 CI (2.054-15.608)], significantly higher frequency of abnormal chest CR [*p* value 0.019, or: 7.886 CI (1.033-60.202)] ; significantly higher frequency of abnormal pelvic CR [*p* value : 0.011; or : 8.545 (CI:

1.121-65.115)]; significantly higher frequency of FAST score of > 3 [p value : ≤ 0.0001 , or 0.034 (0.005-0.256)] as compared to the group of patients with no organ injuries on CT. we observed that the predictors for injuries on CT are: Hemodynamic instability, Altered level of consciousness (GCS≤13), Decreased haematocrit levels, Abnormal physical examination of the abdomen (particularly abdominal tenderness), Fracture of the ribs ,Fracture of the pelvis and FAST score of >3.

Key words

Trauma, Wounds and Injuries, Abdominal Injuries, Blunt Abdominal Injuries.

Introduction

Trauma remains the most common cause of death for all individuals between the ages of 1 and 44 years and is the fifth most common cause of death regardless of age [1]. The combined pedestrian and auto accidents, abdominal traumas account for up to 75% of cases seen, while abdominal blows and falls comprise the rest of the cases [1, 2]. The spleen is the most commonly injured organ is the only intra-abdominal organ injured in over 60% of cases. Liver and hollow viscus injuries are next in incidence [1]. However, it is known that up to 40% of hemoperitoneums do not determine significant signs or symptoms at initial assessment. These false diagnoses result in deaths considered “preventable”, as they would not occur if the lesions had been initially recognized [3]. There are several situations that complicate the diagnosis of abdominal injuries. Physical examination may be unreliable due to the presence of multiple trauma or changes in the levels of consciousness. The parameters of the clinical examination may be masked in patients with exogenous intoxication [4]. Thus, one turns to complementary tests, such as ultrasound and computed tomography.

The Focused Assessment Sonography for Trauma (FAST) is the ultrasound performed in the emergency room in order to detect free intraperitoneal fluid and pericardial effusion in trauma victims. This diagnostic method has limitations, mainly related to the volume of hemoperitoneum present at the examination, besides being dependent on the examiner [5]. Even a complete ultrasound exam, in which there is detailed evaluation of abdominal organs, can be false negative [6].

Unlike DPL (Diagnostic Peritoneal Lavage) or FAST, which has the primary role in the detection of hemoperitoneum, Computed Tomography (CT) has the added advantage of being able to provide more information with regard to the type and extent of intra-abdominal injury, including retroperitoneal injuries. It can also be extended 'beyond' the abdomen to visualise the spine, chest and pelvis. It is however not without drawbacks, being expensive, time-consuming, and potentially hazardous for unstable patients, and associated with exposure to radiation [7]. Over-reliance on CT may result in incomplete resuscitation in the trauma room, or delays in important interventions such as pelvic immobilisation. Most of the rural hospitals in our set-up do not have the luxury of a CT scanner for trauma patients, or do not have professional manpower to interpret such scans.

We know that there are clinical variables that correlate with the presence of abdominal injuries in victims of blunt trauma, which can be called “predictors”, however this association has not been widely studied in our setup. In facilities without widespread availability of definitive imaging services or surgical backup, identification of such risk factors may be useful to prioritise patients in need for further evaluation of possible IAI. This becomes particularly important in South Asian countries where judicious use of recourses is warranted. The aim of our study is to identify predictors of abdominal injuries in victims of blunt trauma.

Materials and methods

In the Emergency Department of the Sher i-Kashmir Institute of Medical Sciences, we conducted a prospective data collection of all trauma patients admitted to the emergency room between May 2013 and June 2015. We collected data on identification, mechanism of injury, vital signs at admission, trauma indices, complementary exams, associated diseases, injuries diagnosed and treatment.

The evaluation protocol for abdominal imaging that is routinely used in our department uses the FAST, complete ultrasound (U.S.) and selectively, computed tomography (CT), depending on the assessment of the risk of abdominal injury by the attending physician. In addition to the imaging investigation, we perform laboratory tests, such as blood count, haematocrit and blood gas analysis for evaluation of possible abdominal injuries.

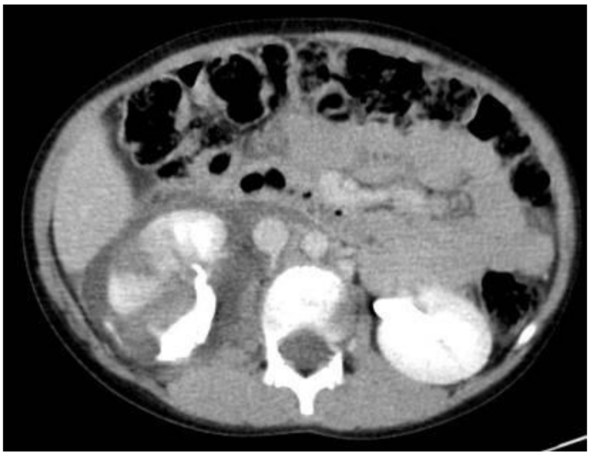
This study was approved by the Ethics Committee on Human Research of our institute. We conducted a prospective analysis of protocols collected in the period from May 2013 and June 2015. We included all blunt trauma victims older than 14 years. Variables were compared between patients with abdominal injuries diagnosed by computed tomography and/or laparotomy and the individuals without abdominal lesions to identify predictors of such injuries.

FAST was performed using Prosound 4, Hitachi Aloka Medical Ltd; in ED ultrasound room by radiology residents with a 24/7 availability. A positive FAST examination was defined as the presence of free peritoneal fluid in the right upper quadrant hepato-renal fossa, the left upper quadrant spleno-renal recess, or the suprapubic pouch of Douglas. Hemoperitoneum detected on US was scored as described by Huang, et al. [8].

CT scans were performed on Somatom Emotion16 Slice configuration, Siemens Medical. A positive abdominal CT was defined, based on the official radiology report, as the presence of any injury to a solid organ, bowel, mesentery, diaphragm or bladder; or the presence of free fluid consistent with haemorrhage, or pneumoperitoneum. Hemoperitoneum on CT was graded as described by Federle and Jeffrey, et al. [9]. IAI was defined as any injury to an abdominal solid organ, bowel, mesentery, diaphragm or bladder identified either by CT or during laparotomy.

The variables which were collected and analysed as potential predictors for the outcome measures were selected from the literature and clinical experience at our centre. These variables consisted of Patient characteristics (age, sex), Blood pressure [10, 11], Heart rate, Glasgow Coma Scale (GCS) [10-12,14], Abnormal abdominal findings at physical examination [10, 12, 14], Haematocrit [14], Fractures of extremities [10], Abnormalities on chest CR [10, 11, 14, 15], Pelvic CR (Conventional Radiography) [10, 11, 13-15], Lumbar spine CR [10, 14], or Free fluid on FAST [10, 14, 15] (**Image – 1 to 4**).

Image – 1: A patient of renal trauma with urinary extravasation.



For analysis, we considered only those variables about which information was present in more than 95% of charts. We used the chi-square or Fisher tests to evaluate categorical variables. Numerical variables are presented as mean ± standard deviation. We used the Student t test to compare means. We considered $p < 0.05$ as statistically significant. We also calculated the odds ratio when appropriate.

Image – 2: Patient of blunt trauma with hepatic laceration.

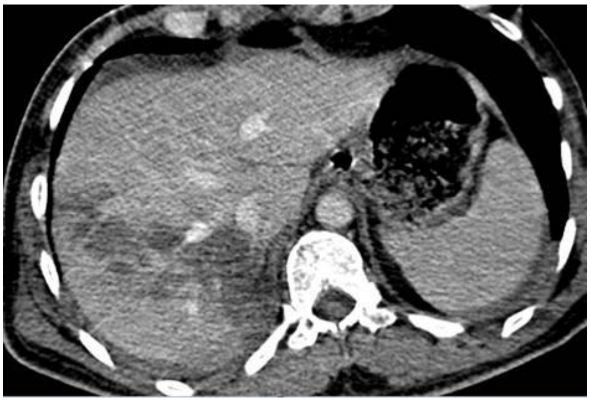


Image – 3: A patient of blunt trauma with renal hematoma.

Image – 4: A patient with blunt trauma showing splenic devascularisation.

Results

During the study period a total of 6990 patients suspected for blunt abdominal trauma underwent FAST examination. Of these 286 (4.1%) were positive, out of which 175 (61.2%) met the inclusion criteria for analysis and the rest 111 (38.8%) patients were excluded. Out of 175 patients, 145 had abdominal injuries on CT/ laparotomy OIS ≥1 and were assigned as group I and 30 patients had no significant organ injury (group II). Blunt trauma abdomen was most common in the age group of 20 – 29 years (n = 48) accounting for about 27.4% of cases. Minimum age was 14 years while maximum age was 70 years. Mean age was 32.94± 14.21, with males (n= 138) out numbering the females (n= 37). Most common mode of injury was road traffic accidents accounting for 69.7% of cases followed by fall from height which accounted for 26.2% of cases. Majority of the patients, 23.4% (n= 41) reached hospital between 1 and 2 hours of injury. The pulse rate of patients ranged from 68 beats/minute to 130 beats/ minute with a mean of 96.04 ± 15.15. The systolic BP ranged from 60 mmHg to 130 mmHg with a mean of 101.28 ± 13.43. Abdominal tenderness was the most common sign, being present in 84% (n=147) of patients. Most common fracture seen was that of pelvis (19%). Splenic injury was the most common injury seen in 48.5% of the patients (**Table - 1**). Among solid organs, for splenic trauma patients, grade III injury predominated and was present in 35.3% (n=30) patients. Majority of patients with liver injury had grade III injury comprising 33.9% (n=18). Grade IV (32%) injury was most common in patients with renal injury (**Table - 2**).

Table - 1: Abdominal injuries identified by laparotomy and/or computerized tomography in victims of blunt trauma.

Organ injured	No. of patients	%
Spleen	85	48.5%
Liver	53	30.2%
Kidney	25	14.2%
Gastrointestinal tract	20	11.4%
Retroperitoneal hematoma	18	10.2%
Mesentery	1	0.05

Table - 2: Grades of solid organ injury in group I.

Organ	Grade of injury	No. of patients	Percentage (%)
Spleen (n=85)	I	8	9.4
	II	21	24.7
	III	30	35.3
	IV	18	21.1
	V	8	9.4
	Total	85	100
Liver (n=53)	I	13	24.5
	II	11	20.7
	III	18	33.9
	IV	11	20.7
	Total	53	100.0
Kidney (n=25)	I	5	20.0
	II	2	8.0
	III	7	28.0
	IV	8	32.0
	V	3	12.0
	Total	25	100.0

Table - 3: Characteristics of numerical variables between group I and group II.

Variable	Group I	Group II	P- value
Age	33.44± 14.02	30.53± 15.13	0.309
Sys B.P.	98.79±12.8	114.1±7.38	≤0.001
Pulse rate	99.29±13.8	80.33±11.06	≤0.001
GCS	11.7±2.02	13.1±1.74	0.001
Haematocrit	29.18±8.31	34.33±6.46	0.031
FAST score	3.55±1.24	1.87±0.90	0.0001

Table - 4: Characteristics of nominal variables between group I and group II.

Variable	P-value	OR	CI
Systolic BP ≤100	≤0.001	30.13	6.88-131.90
GCS Score <11	0.017	3.75	1.23-11.31
Abdominal bruises	≤0.001	6.66	2.42-18.47
Abd. Tenderness	0.001	63.70	20.17-201.21
Guarding/ rigidity	≤0.001	5.66	2.05-15.60
Rib fracture	0.019	7.88	1.03-60.20
Pelvic fracture	0.011	8.54	1.12-65.11
Lumbar spine fracture	0.077	0.57	0.012-2.21
Extremity fracture	0.407	0.66	0.172-2.58
FAST Score>3	≤0.001	0.03	0.005-0.25

The comparison of numerical variables between the groups revealed that patients with intra-abdominal injuries (group I) were characterized by significantly lower haematocrit level (29.18±8.31 vs. 34.33±6.46), Lower mean systolic blood pressure (SBP) on admission (98.79 mmHg ± 12.8 vs. 114.1 ± 7.38), higher mean heart rate on admission (99.29 ± 13.8 bpm vs. 80.33 ± 11.06 bpm), lower mean Glasgow Coma Scale score on admission(11.7± 2.02 vs. 13.1 ± 1.74) and higher FAST scores (3.55±1.24 vs. 1.87± 0.90) as compared to that of patients without intrabdominal injuries (group II) (**Table - 3**). In the comparison of nominal variables between groups, we observed that the group with abdominal injuries had a significantly higher frequency of SBP ≤ 100mm of Hg at admission p ≤ 0.0001, OR 30.130 (6.882-131.907); significantly higher frequency of GCS ≤ 11 at admission p value 0.017, OR 3.754 (1.239-11.312); significantly higher frequency of abdominal bruises p ≤ 0.0001,OR 6.669 CI (2.42-18.47); abdominal tenderness p ≤ 0.0001or 63.708 CI (20.171-201.218) and guarding /rigidity p ≤ 0.0001, OR 5.662 CI (2.054-15.608) at presentation. The highest odds ratio for the presence of abdominal injury on CT was the presence of abdominal tenderness (63.7) among the parameters assessed for abnormal physical examination; The group with abdominal injuries on CT had significantly higher frequency of rib fractures (abnormal chest CR) at admission p value 0.019, OR: 7.886 CI (1.033-60.202); significantly higher frequency of pelvic fractures (abnormal pelvic CR) at admission, p value 0.011; or 8.545 (CI: 1.121 – 65.115) and FAST score of > 3 as compared to the group of patients with no intrabdominal injuries on CT, p value : ≤ 0.0001, or 0.034 (0.005-0.256) as per **Table - 4**.

Discussion

The exact percentage of patients with abdominal injuries due to blunt trauma is not known. In studies where the sample size was large, for example, the one from Mackersie et al., about 3% of victims of blunt trauma had some abdominal injury [11]. In victims of multiple trauma admitted with mild traumatic brain injury, their frequency increases to 10% [16]. In one of the studies, where only patients sustaining "high energy" trauma were studied, Deunk et al. found approximately 30% of abdominal injuries [17]. In the patients of trauma with fractures of the pelvis, the incidence of associated abdominal injuries can be as high as 40% [18]. A normal physical examination does not rule out the possibility of abdominal injury. The clinical history, physical examination and laboratory tests are not reliable as they may show show false negative results [29]. In 2010, Michetti, et al., conducted a study in which they found that 10% of blunt abdominal trauma victims with normal physical examination on admission had abdominal injuries confirmed by imaging (computed tomography) [4]. The FAST and full abdominal ultrasound, methods routinely used for the evaluation of blunt abdominal trauma victims, have the problem of false negativity [5, 14, 15, 17, 19-22]. Although there are various studies in the literature that recommend the routine performance of computed tomography in patients with blunt trauma, but still there are limitations of its use. Intravenous and oral contrast material administration has its own limitations, for example the anaphylactic reactions, furthermore, there is exposure to a dose of radiation, which has been associated with a risk of neoplasia [23]. The risks associated with the transfer of the patient from the ED to the CT room has also to be considered. Performance of a CT requires that the patient must be hemodynamically stable. Another limitation that prevents the routine performance of the computed tomography is its availability, which is not regular, particularly in our rural areas. Abdominal CT also has false negative results, especially in detection of the injuries of the pancreas; Injuries of the gut, particularly the retroperitoneal duodenum and jejunum/ ileum [24, 25]. Trauma care consumes a large part of the health budget [26]. This fact should also be given due consideration while taking in account the systematic indication of computerized tomography in patients with low energy trauma, in which the positivity of the test is hardly more than 5%. Hence the need of selection of patients at higher risk of injury to be submitted to computed tomography was felt. Taking all the above facts into consideration, the idea of studying the variables that may be significantly associated with presence of abdominal injuries was conceived. These predictive factors can help the attending doctor to place a particular patient of abdominal trauma into a higher or lower risk group, hence may allow prioritization of the patients. In 1989, Mackersie, et al. studied the “indirect” signs related to the presence of abdominal injuries in patients who suffered blunt abdominal trauma [11]. These authors noted that the presence of any of the following findings- base excess lower than -5mEq/L, arterial hypotension, or injuries to the chest and pelvic fractures were significantly associated with the presence of abdominal injuries. In 2010, Deunk et al. proposed a selective indication for CT based on clinical, radiological, laboratory and ultrasound findings [17]. In a study of 1,040 patients of high-energy trauma, they found that the following factors were significantly associated with the presence of abdominal injuries: plain chest X ray changes, abnormal spine or pelvis radiography, positive FAST, abnormal abdominal examination, changes at the physical examination of the spine, base excess less than -3mEq/L, systolic BP less than 90mmHg and fractures in long bones. Based on these data, they further proposed that CT is indicated in hemodynamically stable patients who presented with: impaired neurological examination (GCS< 8, Anisocoria, skull fracture), abnormal abdominal physical examination, lumbar, pelvic or extremities fractures, base excess less than -3mEq/L, abnormalities on chest radiography, or positive FAST [17]. Of particular concern are the patients with reduced level of consciousness, particularly the patients with severe traumatic brain injury. Since the abdominal physical examination in patients with traumatic brain injuries becomes unreliable, and hence serious injuries may go unnoticed, even in computerized tomography. The lesions most feared are hollow visceral injuries, because late diagnosis often have serious consequences [27]. In this particular group of patients, the diagnosis by computed tomography is more difficult. Many studies have been performed to evaluate the predictors of abdominal injuries in victims of blunt trauma. In 2004, a study performed by Beck et al. found a significant relationship between the presence of abdominal injuries and abnormal radiographs of the pelvis and the need for endotracheal intubation [13]. The data found in our sample clearly show the association of abdominal lesions with a few variables: Hemodynamic instability (Systolic BP<100, Increased HR), Altered level of consciousness (GCS≤11), Decreased haematocrit levels, Abnormal physical examination of the abdomen (particularly abdominal tenderness), Fracture of the ribs, Fracture of the pelvis and FAST score of >3. Many of these findings are consistent with the studies that have been cited above [11, 13, 17]. In our study, the chance of a trauma patient with a fractured pelvis presenting with an abdominal injury is 8.54 times higher when compared with patients without this type of fracture. The association of the chest injuries with abdominal injuries is already known [11]. In our sample, the chance of a trauma patient with a rib fracture presenting with an abdominal injury is 7.88 times higher when compared with patients without this type of fracture. Increased chance of injury in abdominal trauma with fractures of spine was not seen in our study, as was concluded by Rabinovici R, et al., [28]. However, we consider important to note that in our study the incidence of abdominal injuries was also higher in the presence of Systolic BP ≤100, GCS Score <11, Abdominal bruises, Abdominal Tenderness and Guarding/ rigidity. From the above mentioned facts, it must be clear that for a proper diagnosis of intrabdominal injuries in a patient of trauma, the patient should be viewed as a whole, as the changes secondary to intarabdominal lesions can also be found in other body parts. The purpose of our study was precisely to widely assess which variables could be associated with abdominal injuries. Certainly, the use of the data from our study can be very useful in identifying lesions that initially could go unnoticed, and hence may contribute to decreased morbidity and mortality associated with late and missed diagnosis of abdominal injuries in victims of blunt trauma.

Conclusion

Data from this study leads us to the conclusion that the predictors of abdominal injuries in victims of blunt trauma are: mechanism of injury, hemodynamic instability, reduced level of consciousness and presence of fractures in the chest or pelvis. Utilizing this data, a potentially more cost effective and safer approach can be devised to screen for abdominal injury in patients with blunt abdominal trauma, thereby leading to selection of patients for CT scans in our emergency rooms.

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