



Determinants of Successful Non-Operative Management of Intra-Peritoneal Bleeding Following Blunt Abdominal Trauma

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ABSTRACT

Objectives: To identify the predictive factors of successful non-operative management of patients with intraperitoneal bleeding following blunt abdominal trauma.

Methods: This was cross-sectional study being performed in our Level I trauma center in southern Iran between 2010 and 2011. We included adult (>14 years) patients with blunt abdominal trauma and intra-peritoneal hemorrhage detected by CT-Scan who were hemodynamically stable and did not require any surgical intervention. Patients were managed conservatively in ICU. Those who required laparotomy during the study period were named as non-operative management failure (NOM-F) while the other were non-operative management success (NOM-S). The baseline, clinical and laboratory characteristics were compared between two study groups in order to detect the predictors of successful NOM of intra-peritoneal bleeding.

Results: Overall we included 80 eligible patients among whom there were 55 (68.7%) men and 25 (31.3%) women with mean age of 30.63.6± years. Finally, 43 (53.8%) were successfully managed conservatively (NOM-S) while 37 (46.2%) required laparotomy (NOM-F). We found that those who underwent emergency laparotomy had significantly higher Δ Hb ($p=0.016$) and lower base deficit ($p=0.005$) when compared to those who were successfully managed conservatively. Those who required surgical intervention had significantly lower baseline systolic blood pressure ($p<0.001$) and higher shock index ($p=0.002$). The other parameters such as pulse rate and respiratory rate were comparable between two study groups.

Conclusion: In patients with intra-peritoneal bleeding following blunt abdominal trauma, the most reliable predictive clinical and para-clinical factor of successful non-operative management are shock index and systolic blood pressure on arrival, base deficit and hemoglobin drop within first 12 hours of admission.

Keywords: Blunt abdominal trauma; Intra-peritoneal bleeding; Non-operative management; Conservative therapy.

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Introduction

Blunt abdominal trauma is amongst the most common complications of road traffic accidents.

It has been reported that about 31% of patients with multiple trauma suffer from abdominal injuries [1,2]. In the same way about 13% and 16% of these patients have hepatic and splenic injuries respectively

[3]. According to standard ATLS guideline, all the patients with blunt abdominal injuries who are hemodynamically unstable and have signs of exsanguination should undergo emergency laparotomy, however, selecting these patients, especially in the multiple trauma patients remains a challenge [4]. High rate of operative complications caused paradigm shift from operative to non-operative management in hemodynamically stable blunt abdominal trauma patients [5,6]. Repeated clinical examination supplemented with modern imaging and laboratory investigations play a key role in reaching therapeutic decisions, thus preventing unnecessary laparotomies [7].

Intra-peritoneal bleeding is mainly caused by liver and spleen rupture and if not managed properly can lead to hypovolemia and subsequent death [4]. There are two general approaches for treatment of intra-peritoneal bleeding followed by blunt abdominal trauma; surgical and non-surgical approaches [8-10]. Recent guidelines on management of hepatic injuries indicate that non-operative management of blunt hepatic injuries currently is the treatment modality of choice in hemodynamically stable patients, irrespective of the grade of injury or patient age [8]. Non-operative management of blunt hepatic injuries should only be considered in an environment that provides capabilities for monitoring, serial clinical evaluations, and an operating room available for urgent laparotomy. Patients presenting with hemodynamic instability and peritonitis still warrant emergent operative intervention [8]. The similar guideline has been published in regards to blunt splenic injuries [9].

Since the issue of selecting the most appropriate approach has been recently a point of conflict in management of internal bleeding following an abdominal blunt trauma, and criteria for non-operative management are being changed frequently, we are going to identify some of the determining factors of successful non-operative management, in our level I trauma center in Southern Iran.

Materials and Methods

Study Population

This was cross-sectional study being performed in Shahid Rajaei hospital, a Level I trauma center affiliated with Shiraz University of Medical Sciences during a 1-year period between 2010 and 2011. We included those adult patients (>14 years) with blunt liver and/or splenic trauma confirmed by abdominal computed tomography (CT) scan admitted to our center during the study period. Patients who were hemodynamic unstable (patients with systolic arterial blood pressure (SAP) lower than 90mmHg on admission unresponsive to fluid resuscitation), those with altered mental status (GCS<14), patients with peritoneal signs on physical examination, identification of other coexisting abdominal organ

damages in abdominal CT scan and patients who needed any other emergency operation during the first 72 hours were excluded from the study. The study protocol was approved by institutional review board (IRB) and medical ethics committee of Shiraz University of Medical Sciences. All the patients or their guardians provided their informed written consents before inclusion in the study.

Study Protocol

All the patients included in the study underwent complete history and physical examination by the senior general surgery resident and the findings were recorded in a data gathering form. We recorded demographic and baseline information including age, sex, mechanism of injury, associated injuries, systolic arterial pressure, hemoglobin, arterial blood gas (ABG), sodium (Na), potassium (K), calcium (Ca) and base deficit. All patients were managed supportively with close observation in intensive care unit (ICU) and daily measurement of serum lactate and Ca. Serum hemoglobin, Na, K, base deficit, and ABG. Vital signs were recorded every 6 hours. We also recorded the changes of hemoglobin through the first 12-hour of admission (Δ Hb). Shock index was calculated by the following equation:

$$\text{Shock index} = (\text{Heart rate}) / (\text{Systolic blood pressure})$$

Patients with hemodynamic instability, decreasing hemoglobin attributable to injury despite transfusion of up to 2 units of packed red blood cells in 24 hours and physical signs of peritonitis immediately underwent surgical repair. This group was called the non-operative management failure (NOM-F). The group of patients who succeeded the non-operative management was named the non-operative management success (NOM-S). All patients of the NOM-S group underwent ultrasound of the abdomen followed by CT scan for result evaluation. Two study groups were compared regarding the baseline and outcome characteristics in order to determine the predictive factors of successful non-operative management of intra-peritoneal bleeding.

Statistical Analysis

All data were analyzed using statistical package for social sciences (SPSS Inc., Chicago, USA) version 17.0. Data are expressed as mean \pm SD and proportions as appropriate. In order to compare the proportions between two study groups we used chi-square test and Fisher's exact test where appropriate. Independent sample t-test was used to compare the parametric data between two study groups. A 2-sided *p* value less than 0.05 were considered statistically significant.

Results

Overall we included 80 eligible patients among whom there were 55 (68.7%) men and 25 (31.3%)

women with mean age of 30.6±3.6 years. Liver injury was detected in 29 (36.2%) Patients while 20 (25%) patients suffered from spleen injuries and 13 (16.25%) patients were found to have concomitant injury of spleen and liver. Table 1 summarizes the baseline characteristics of the patients included in the study. From 80 patients who were treated conservatively in the first instance 37 (46.2%) patients required laparotomy; so we consider them as NOM-F. Therefore 43 (53.8%) patients in the study were managed conservatively successfully without any surgery needed (Table 1).

Table 2 compares the baseline, clinical and laboratory findings between those who were managed conservatively and those who required surgical intervention. We found that those who underwent emergency laparotomy had significantly higher ΔHb when compared to those who were managed conservatively ($p=0.016$). In the same way, the base deficit was significantly lower in those who required surgical intervention compared to those who were successfully managed conservatively ($p=0.005$). The other parameters such as baseline Hb ($p=0.104$), pH ($p=0.072$), HCO_3^- ($p=0.144$), Na ($p=0.148$), K ($p=0.727$), Ca ($p=0.286$), WBC ($p=0.104$) and platelet ($p=0.72$) were not significantly different between two study groups (Table 2).

The most valuable parameters in physical exam

Table 1. Baseline characteristics of 80 patients with abdominal blunt trauma and intra-peritoneal bleeding included in the study.

Characteristic	Value
Age (years)	31.1±3.8
Gender	
Men (%)	55 (68.7%)
Women (%)	25 (31.3%)
Mechanism of injury	
Motor vehicle accident (%)	32 (40%)
Struck as pedestrian (%)	30 (37.5%)
Fall (%)	7 (8.75%)
Blunt assault (%)	11 (13.5%)
Solid Organ injury	
Liver (%)	29 (36.2%)
Spleen (%)	20 (25%)
Both liver and spleen (%)	13 (16.25%)
Outcome	
Non-operative management success (%)	43 (53.8%)
Non-operative management failure (%)	37 (46.2%)

and clinical manifestations were the systolic blood pressure and shock index. Those who required surgical intervention had significantly lower baseline systolic blood pressure ($p=0.000$) and higher shock index ($p=0.002$). The other parameters such as pulse rate and respiratory rate were comparable between two study groups.

Table 2. Comparing the baseline, clinical and laboratory parameters between those who were managed conservatively and those who required surgical intervention.

Characteristic	NOM-S (n=43)	NOM-F (n=37)	P value
Age (years)	30.6±3.6	32.3±4.8	0.495
Gender			
Men (%)	29 (67.4%)	26 (74.3%)	0.085
Women (%)	14 (32.6%)	9 (25.7%)	
Mechanism of injury			
Motor vehicle accident (%)	16 (37.2%)	16 (43.2%)	0.388
Struck as pedestrian (%)	15 (34.8)	15 (40.5%)	
Fall (%)	5 (11.6%)	2 (5.5%)	
Blunt assault (%)	7 (16.2%)	4 (10.8%)	
Solid organ injury			
Liver (%)	8 (18.6%)	21 (56.7%)	0.061
Spleen (%)	12 (27.9%)	8 (21.6%)	
Both spleen and liver (%)	9 (20.9%)	4 (10.8%)	
Shock index	0.77±0.15	0.97±0.36	0.002
Systolic blood pressure (mmHg)	118.62±16.95	102.57±17.25	<0.001
Hemoglobin baseline (mg/dL)	11.9±3.9	11.01±5.1	0.104
Delta Hemoglobin (mg/dL)	0.1±1.2	0.96±1.6	0.016
White blood cell (per mm³)	11.9±0.86	11.01±1	0.104
Platelet (*10⁶)	254684±51487	216126±32014	0.720
Sodium (meq/dL)	139±2.3	141±1.9	0.148
Potassium (meq/dL)	4.2±0.26	4.1±0.19	0.727
Calcium (Ca)	10±1.4	8.7±2.8	0.286
Arterial blood gas (ABG)			
pH	7.3820±0.078	7.2839±0.148	0.072
HCO_3^-	20.7±3.1	19.1±6.11	0.144
PCO_2	38.4±2.1	40.1±2.9	0.264
Base deficit	1.14±1.8	5.6±2.36	0.002

Discussion

NOM still remain a challenge to Trauma Surgeons because of varied clinical picture on arrival. The associated injuries, alcohol and drugs may mask abdominal signs and symptoms. Patients with short pre-hospital transport time have initial subtle clinical features affecting early diagnosis. Around 20 to 40% patients with radiologically significant hemoperitoneum may not have any significant clinical findings [11]. Hemodynamically stable patients with solid organ injury should be considered for NOM after ruling out bowel trauma. Published literatures have shown that radiological grade of severity of injury is not a contraindication for NOM [12]. The aim of the current study was to determine the clinical and laboratory predictors of successful non-operative management of these patients.

In the current study, liver injury was the most obvious cause of intra-abdominal bleeding due to blunt abdominal trauma which is in contrast with previous study being performed in Greece which showed that spleen injuries are the most common cause of intra-abdominal bleeding followed by liver, then came coincident liver and spleen injuries [13]. Also Davis *et al.*, [14] at 1976 had reported the spleen again as the most frequent of the injuries occurring as an isolated intra-abdominal organ injury, and splenectomy operation was performed to all patients with spleen injury. Liver was the second organ in accordance as an isolated injury and was associated with high mortality and morbidity [14].

Nowadays trauma centers recommend non-operative management of blunt abdominal injuries (liver and spleen) in hemodynamically stable patients [8,9]. In our study, we successfully managed 43 (53.8%) patients by non-operative approach; which was slightly similar to Markogiannakis study [15]. Their study included 2580 patients divided into two groups (Op) group (32.3%) in which patients were directly operated, and NOM group (67.7%) in which 80% of cases were successfully managed conservatively.

Differentiating the indications for admission of patients with blunt abdominal trauma in intensive care units (ICU) and intermediate care units is an important matter for specified trauma centers regarding economic issues. So it can be concluded that point of care evaluation elements should be investigated for their significance in prediction of severity of abdominal trauma and most effective management; intensive care, intermediate care or operative approach. Several studies have recommend laboratory tests such as hemoglobin (Hb), hematocrit (Hct), white blood cells count (WBC), ABG, liver function test (LFT), Na, K, BUN (blood urea nitrogen) to guide resuscitation or to suggest severity of trauma or massive internal bleeding. Our study showed that many of first laboratory tests on admission including Na, K, Ca, HCO₃, pH and Hb cannot be valuable determinants of choosing the best management

protocol. In a study by Asimos and co-workers [16], the influence of a point of care blood laboratory testing (Hb, Na, K, Cl, BUN, pH, PCO₂, PO₂, HCO₃, base deficit, and lactate), was evaluated in blunt abdominal trauma patients. They showed that that Na, K, Ca, and BUN level do not influence the initial management of major trauma patients [16]. First panel including Hb, HCO₃, pH, Na, K, Ca, WBC and platelet count had no role in the type of management in our study, but initial base deficit, shock index and delta Hb were important determinants of successful non-operative management. These initial evaluations have most significance for determination of intensive or intermediate care as well success rate for non-operative management. In the same way two large recent studies have indicated that non-operative management of blunt hepatic and splenic injuries currently is the treatment modality of choice in hemodynamically stable patients, irrespective of the grade of injury or patient age. Non-operative management of blunt hepatic and splenic injuries should only be considered in an environment that provides capabilities for monitoring, serial clinical evaluations, and an operating room available for urgent laparotomy. Patients presenting with hemodynamic instability and peritonitis still warrant emergent operative intervention [8,9].

Regarding the first 24-hour measurements that predict better prognosis for non-operative management, there have been studies to introduce valuable factors. Schnüriger and collages [17] reported that there is significant increase in WBC count with increasing Injury Severity Score (ISS). Also Poletti and colleagues [18] reported that serum aspartate transaminase (AST) and WBC were the most sensitive and specific data to predict severity of abdominal injury and found that after blunt trauma AST was the most significant, and WBC was the next preferred predicting factor. Gonzalez and co-workers [19] also reported that before emergent extra-abdominal trauma surgery, abdominal evaluation with physical examination is sufficient to identify surgically significant abdominal injury in the awake and alert blunt trauma patient. Matsushima *et al.*, [20] also evaluated the approach to blunt abdominal injuries in adult and pediatric patients. They included a total of 1532 patients with at least one solid organ injury: 946 patients had a splenic injury, 505 had a liver injury, and 424 had a kidney injury. They reported that spleen and liver procedures were performed more often in adults irrespective of injury grade [20]. Thus age was identified as a predictor for non-operative management of blunt solid organ injuries.

In our study we detected significant changes in failure of non-operative management in patients who had >1gr/dl decrease in serum hemoglobin level in the first 12 hours of admission; so that we can introduce Δ Hb which we calculated as subtraction of 12-hour hemoglobin from the initial hemoglobin. This index can be reliable predictive factor for successful non-operative management.

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