Role of plasma ammonia level in detecting intra-abdominal hemorrhage following blunt abdominal trauma

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Abbreviations:

BAT: Blunt Abdominal Trauma.

PR: Pulse Rate.

SBP: Systolic Blood Pressure.

DSP: Diastolic Blood Pressure.

RR: Respiratory Rate.

GCS: Glasgow Coma Scale.

ATLS: The Advanced Trauma Life Support.

SD: Standard Deviation

Abstract

Background:

Blunt abdominal injury is a major cause of death in trauma cases. It will be very helpful if intra-abdominal bleeding can be predicted by laboratory tests. The aim of our study is to evaluate the accuracy of plasma ammonia in detecting intra-abdominal hemorrhage in patients with blunt abdominal injury.

Materials and Methods:

In this study, 60 patients admitted to Azadi teaching hospital complaining from blunt abdominal trauma were included. On admission to emergency room, plasma ammonia levels were measured. Demographic data, vital signs, and GCS reports were written down. Findings of abdomino-pelvic computed tomography scan and intraoperative laparotomy were supposed as a gold standard for abdominal injuries. We excluded patients with preexisting liver diseases or impairment.

Results:

In this study 60 patients were involved. 6 patients had intra-abdominal bleeding and their mean plasma ammonia level was much higher than the rest. (205.33±100.2 vs. 51.29±23.38, $P < 0.001$). ROC curve analysis revealed Accuracy 96.7% Sensitivity 83.3% Specificity 98.1%.

Conclusion:

The study results advocate that an increase in plasma ammonia level in patients with blunt abdominal trauma would be a useful predictor for intra-abdominal hemorrhage. This can be a great opportunity for hospitals lacking advanced facilities like contrast enhanced CT scan or diagnostic laparoscopy.

Introduction:

Trauma originates from the Greek word meaning 'wound'.[1]

It is defined as cellular disruption caused by environmental energy that is beyond the body's resilience, which is compounded by cell death due to ischemia/reperfusion. [2]

Trauma is the most common cause of death for all individuals between the ages of 1 and 44 years, and is the third leading cause of death regardless of age. [1]

The abdomen is the third most commonly injured part of the body and is affected in 7%–10% of trauma victims, and about 70%–80% of abdominal trauma is blunt. [3][4]

Uncontrolled bleeding remains major problem, responsible for 40% trauma-associated mortality, which can be prevented by early intervention.

In general abdominal trauma is classified into blunt and penetrating. The most frequent one is blunt trauma, with motor vehicle accident as a leading cause. While in penetrating abdominal trauma, the most common cause is stabbing. [1][2]

Blunt traumas are more common in agricultural areas, while penetrating traumas predominate in cities.

Penetrating injuries can be easily and reliably diagnosed with low chance of missed injuries.

A high index of suspicion for blunt injuries must be kept based on the mechanism of injury because positive findings can be missed by primitive clinical evaluation. Furthermore,polytrauma patients may have altered conscious status or diverting injuries making examination alone to be insufficient in the early identification of abdominal injuries. [6]

Primary survey:

The Advanced Trauma Life Support (ATLS) course of the American college of surgeons committee on trauma was developed in the late 1970s. based on the premise that appropriate and timely care can improve the outcome for the injured patients. ATLS provides a structured approach to the trauma patient with standard algorithm of care; it emphasizes the golden hour concept that timely, prioritized interventions are necessary to prevent death and disability. [2]

The initial management of seriously injured patients consists of two phases that include the primary survey/concurrent resuscitation, the secondary survey/diagnostic evaluation, definitive care, and the tertiary survey.

The first step in patient management is performing the primary survey, the goal of which is to identify and treat conditions that constitute an immediate threat to life.

The ATLS course refers to the primary survey as assessment of the''ABCs'' (Airway with cervical spine protection, Breathing, and Circulation).

Scoring systems have been established to give an objective criterion for predicting the morbidity and mortality in trauma patients, which aids in the decision of optimum management strategy. These scoring systems either measure the conversion in patient's physiology; Glasgow Coma Scale (GCS) and Revised Trauma Score (RTS) or anatomy; Injury Severity Score (ISS). [(1)(2)]

Ultrasonography is considered the best modality in the initial evaluation of blunt abdominal trauma patients especially in hemodynamically unstable patients as it is noninvasive, requires minimal preparation time, and can be readily performed in the emergency area by an emergency physician. It can be safely repeated for follow-up evaluation as unlike computed tomography (CT) scan it does not poses the risk of high-dose radiation. Focused assessment of trauma with sonography (FAST) has become an important adjunct in the primary survey of trauma patients and has become a “must-have” modality in modern emergency departments. [(14)]

We investigated the significance of ammonia levels estimation in blunt trauma abdomen patients to predict internal hemorrhage.

MATERIALS AND METHODS

This study was performed as a prospective observational survey. In a period of 4 months from November 2020 to February 2021, every case of blunt abdominal trauma presented to the emergency room of Azadi teaching hospital was included in the study.

Exclusions in this study are:

1. Patients with cardio-respiratory suppression/arrest.
2. Penetrating injuries.
3. liver and kidney diseases
4. Injuries that would lead to significant hemorrhage
5. Patients who received pre-hospital intravenous (IV) fluid or blood components before sampling as IV hydration could change the value of plasma ammonia.
6. Period time exceeding 1 h from insult to blood sampling (knowing that plasma ammonia has a short half-life less than 20 minutes) so delayed sampling could affect our results.

Patients presented to Azadi teaching hospital emergency department with blunt abdominal traumas (due to motor vehicle accident, fall from height or direct trauma to the abdomen) were included in our study.

The ATLS (Advanced Trauma Life Support) system delineates an order of priorities set by ABCD; that is, Airway, Breathing, Circulation and Disability (neurology). This system is used in our emergency department. (1)(2)

Demographic data (name, age, gender and address), vital signs (BP, PR, RR), GCS were documented on admission. Blood sampling was taken from the patients for blood sugar, renal function test, CBC and virology. Imaging done (X-ray, sonography and native CT scanning)

Laparotomy was considered standard for determining intra-abdominal hemorrhage. Plasma ammonia level was measured at time of admission.

Blood sample preparation

Five ml of venous blood was taken from the anticubital fossa veins and transferred into Ethylenediaminetetraacetic acid (EDTA) containing sterile tube, extreme caution was taken to process the sample in cold environment and swift way.

The sample was centrifuged at 5000 rpm for 5 minutes, and then the plasma was used for analysis.

Ammonia measurement

Plasma ammonia was measured spectrophotometrically using kit supplied by Biolabo SAS (France) using spectrophotometere machine, by using GLDH (Glutamate dehydrogenase) > 9300 IU/L. [20]

RESULTS

Demographic data and clinical presentation:

Variables	Results (%)
Age (years) mean±SD	29.71±12.75
Gender (male) mean	53 (88.3%)
PR mean±SD	88.7±17.45
SBP mean±SD	122.18±18.39
DBP mean±SD	75.31±9.95
RR mean±SD	17.66±3.85
GCS mean±SD	14.71±0.94
Ammonia mean±SD	66.7±59.45
Management conservative mean	54 (90%)

The overall mean of plasma ammonia for all cases was 66.7±59.45

The mean plasma ammonia level among patients with no intra-abdominal hemorrhage was 51.29±23.38

While the mean of plasma ammonia in patients with intra-abdominal injury was much higher 205.33±100.2

Only one patient with intra-abdominal injury had normal plasma ammonia level, the patient had spleenic injury.

	high ammonia	**normal ammonia**	***Marginal Row Totals***
positive hemorrhage	5 (0.6) [32.27]	1 (5.4) [3.59]	6
nagative hemorrhage	1 (5.4) [3.59]	53 (48.6) [0.4]	54
Marginal Column Totals	6	54	60 (Grand Total)

The chi-square statistic is 39.8354. The *p*-value is < 0.00001. Significant at $p <$ 05.

The chi-square statistic with Yates correction is 31.2963. The *p*-value is < 0.00001. Significant at $p < .05$.

Results

Sensitivity

83.33%

Specificity

98.15 %

Positive likelihood ratio

45

Negative likelihood ratio

0.1698

PPV

83.33%

NPV

98.15%

Accuracy

96.67%

Unpaired t test results (PR and plasma ammonia)

P value and statistical significance:

The two-tailed P value equals 0.0069

By conventional criteria, this difference is considered to be very statistically significant.

Confidence interval:

The mean of PR minus Ammonia equals 22.0000

95% confidence interval of this difference: From 6.1603 to 37.8397

Intermediate values used in calculations:

t = 2.7504

df = 118

Standard error of difference = 7.999

(independent t-test, P < 0.001)

ROC curve Summary statistics:

Number of Cases: 60

Number Correct: 58

Accuracy: 96.7%

Sensitivity: 83.3%

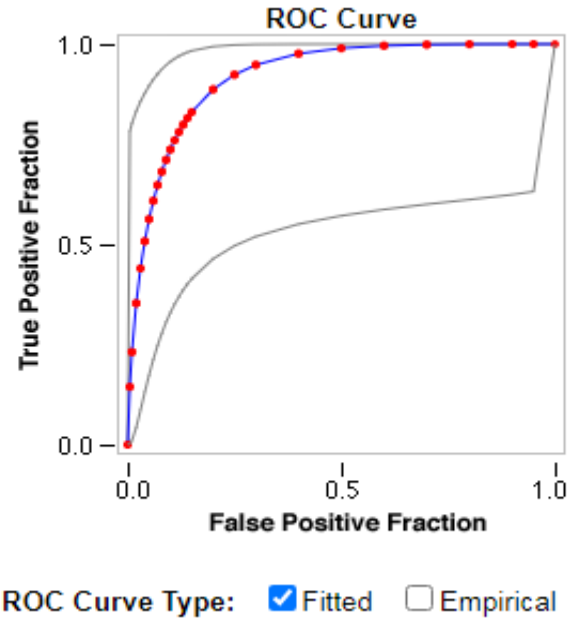
Specificity: 98.1%

Positive Cases Missed: 1

Negative Cases Missed: 1

Fitted ROC Area: 0.92

Empiric ROC Area: 0.9



Key for the ROC Plot

RED symbols and BLUE line: Fitted ROC curve.
GRAY lines: 95% confidence interval of the fitted ROC curve.
BLACK symbols ± GREEN line: Points making up the empirical ROC curve

DATA CHARACTERISTICS:

Data collected in 6 categories with category 6 representing strongest evidence of positivity (e.g., that abnormality is present).

Number of actually negative cases = 54

Number of actually positive cases = 6

Discussion

In our study road traffic accident was the major cause of blunt abdominal trauma.

(56 from 60 cases) could be due to increasing number of vehicles in the streets or reckless driving by young aged males 40 cases below 30 years of age and 53 male cases.

On admission to the emergency department blunt trauma patients are evaluated by physical, clinical, laboratory and imaging parameters. In areas lacking advanced facilities (contrast enhanced CT scanning or diagnostic laparoscopy), a simple test predicting intra-abdominal hemorrhage would be very beneficial. Plasma ammonia level found to be elevated in patients with intra-abdominal bleeding.

When the patient has intra-abdominal bleeding there will be decreasing blood flow to the liver which may lead to impairing of liver function. Consequently causing reduction in the production of glutamine in peri-central hepatocytes and reduced production of urea in peri-portal hepatocytes. Therefore ammonia excretion will be diminished and the plasma ammonia level will be increased. [13,18]

Enzymes of the intestinal bacteria which acts on it produces ammonia which diffuses freely and furthermore the liver cannot detoxify ammonia due to its impairment because of reduced hepatic blood flow. [15,16,17]

A similar study was done by Hagiwara and Sakamoto which included 282 trauma patients in two groups, with and without intra-abdominal hemorrhage. The mean ammonia level in the first group was significantly higher, 113 ± 52.2 versus 55.4 ± 20.8μg/dl. Sensitivity and specificity of plasma ammonia level in the diagnosis of intra-abdominal bleeding in blunt trauma patients were 82% and 89%, respectively. Our results are a bit different than theirs. They chose the cut-off level of 77μg/dl, but we calculated 5 different cut off points. Aside from, the patient's number encountered in their study was more than ours. [12]

Also similar study done by Davood Farsi. In their study they used 5 cutoff points and the sensitivity and specificity of the plasma ammonia level in detecting intra-abdominal hemorrhage was ranging from 80 to100 and 91 to 95.5 respectively. [19]

While in our study we included 60 patients presented with blunt abdominal trauma to Azadi teaching hospital and we found that the mean plasma ammonia level among patients with no intra-abdominal hemorrhage was 51.29±23.38, while the mean of plasma ammonia in patients with intra-abdominal injury was much higher 205.33±100.2.

Sensitivity and specificity were 83.3% & 98.1% respectively.

In our study we reached a correlation between plasma ammonia level and PR, (independent t-test, $P < 0.001$). Mean and standard deviation of pulse rate in cases with high ammonia level was 123.8 and 11.63 respectively.

We also found that patient with intra-abdominal injury (which was confirmed later by intra-operative findings) had increased plasma ammonia level. Moreover, we found that patients with simple traumas had low plasma ammonia level, conservative management and follow up of these patients by clinical assessment and imaging revealed no intra-abdominal hemorrhage.

We had a single false positive case which was patient with pelvic fracture.

If a patient presents with blunt abdominal trauma and has increased plasma ammonia level this can be an alarm to do further evaluation or intervention.

Conclusion:

The decision whether to operate the patient or not is a major issue in blunt abdominal trauma victim. There is no reliable test to ensure that there is intra-abdominal hemorrhage. Our study proposes that the measurement of plasma ammonia level at time of admission may be useful in detecting intra-abdominal hemorrhage. Additional studies are needed with larger number of patients to evaluate the efficacy of the test.

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