Arterial ammonia levels: Prognostic marker in traumatic hemorrhage

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Abstract

Background: In blunt trauma, extent of hemorrhage cannot be determined by physical examination, and vital signs may also not give clear picture in all the patients, especially young healthy ones. Hemorrhagic shock has been reported to increase blood ammonia levels. Arterial ammonia was analyzed in blunt trauma abdomen patients and correlated with shock index (SI). Its predictive value was determined for timely decision of intervention. **Materials and Methods:** Hundred blunt trauma abdomen patients presented in the emergency ward of tertiary care hospital were included in the study. Group I comprised 62 patients requiring either blood transfusion ≥2 units and/or intervention to control bleeding within 24 h following admission. Group II had 38 patients: Not requiring transfusion/intervention during hospital stay. Arterial blood sample was taken immediately after admission; ammonia was analyzed within 20 min of sampling on Cobas 6000 (Roche). SI was calculated. Predictive value of ammonia was determined using receiver operating characteristic curve. **Results:** Ammonia levels and SI were significantly ($P < 0.001$) higher in Group I compared to Group II patients (68.55 ± 14.36 umol/L vs. 37.55 ± 7.41 umol/L and 1.28 ± 0.5 vs. 0.74 ± 0.12, respectively). Significantly higher number of patients in Group I (88.7% vs. 13%) had SI > 0.9. Ammonia levels were significantly higher in patients with complications and in those expired. **Conclusions:** Ammonia levels were significantly higher in patients requiring blood transfusion/intervention in 24 h of admission. The best cutoff value to maximize sensitivity and specificity was ammonia >58.85 μmol/L. Ammonia estimation at admission can be clinically significant indicator of traumatic hemorrhage needing intervention.

Key words: Arterial ammonia, blunt trauma abdomen, intervention

Introduction

Trauma is a major cause of mortality in the younger population. Uncontrolled bleeding remains major challenge, responsible for 40% trauma-related deaths, which could be prevented by timely intervention.[1,2] In blunt trauma, extent of hemorrhage cannot be determined by physical examination, as vital signs may not give a clear picture in all the patients, especially young healthy once. Although abnormal vital signs does indicate shock but the absence of abnormality does not exclude hypoperfusion in trauma patients.[3] Physiological compensation can mask true nature and severity of situation in these patients.[4]

Decision-making is difficult, regarding surgical intervention to treat injuries hidden from physical examination. These patients are intensely vasoconstricted and may suffer end organ ischemia even with normal systolic blood pressure (SBP).[5] Although shock index (SI) can be a useful parameter in acute hemorrhage, but it still needs

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more study in its support to be better than simple vital sign analysis.[6]

Blood ammonia has been shown to be elevated in hemorrhagic shock in animals and humans.[7,8] It is a signal of blood in abdominal cavity due to blunt trauma. Intestinal bacterial enzymes acting on it produces ammonia which is freely diffusible and moreover liver in not fit for detoxification of ammonia.[9]

We investigated the significance of ammonia levels estimation in blunt trauma abdomen patients to predict internal hemorrhage, complications and correlated with need of intervention.

Materials and Methods

One hundred blunt trauma abdomen patients (>12 years old) presented in Trauma Ward/Emergency Department of tertiary care hospital were included in the study. They were divided into two groups. Group I required blood transfusion ≥2 units and/or intervention to control bleeding within 24 h following admission. Group II not requiring transfusion or intervention during hospital stay. Arterial blood sample was taken immediately after admission for ammonia estimation. It was analyzed within 20 min of sampling on autoanalyser Cobas 6000 (Roche Diagnostics India Pvt Ltd). SI (heart rate/SBP) was also calculated.

Routine investigations such as blood sugar, kidney function test, hemogram, X-ray chest, and ultrasound abdomen were done at admission. Contrast-enhanced computed tomography abdomen/chest carried out where ever needed. Complication during the hospital stay and final outcome of the patient were also noted. Study protocol was approved by the Ethical Committee of the institution.

Statistical analysis

The difference between two groups was seen by applying *t*-test. The level of significance considered was 0.05. Diagnostic value was obtained using receiver operating characteristics curve.

Results

Group I comprised 62 patients, forty patients needed intervention and blood transfusion both, whereas 22 patients needed only ≥2 units of blood. Group II comprised 38 patients not requiring transfusion or intervention. Average age was 31.84 ± 14.8 and 32.37 ± 13.6 years, respectively, almost same in both the groups. Male preponderance was noted in both the groups. Motorcycle/motor vehicle accident was a major cause of injury. Most of the patients had more than one organ system involved and most frequently injured organ was liver (40%) followed by spleen (29%). Mean SI and arterial ammonia levels were significantly higher in Group I compared to Group II patients [Table 1]. About

88.7% patient of Group I had SI > 0.9 compared to only 13.1% patients in Group II [Table 2]. Significantly higher number of patients developed complications in Group I compared to Group II (38 vs. 7) and 8% mortality rate was noted in Group I only. Patients, who developed complications or died, had higher levels of ammonia at admission [Table 3 and Figure 1].

Receiver operating characteristics analysis

The cutoff point for ammonia levels is > 58.85 μmol/L (sensitivity 77.42% and specificity 93.37%). Positive predictive value and negative predictive value at this point are 96.7% and 78.9%, respectively.

Discussion

Roadside accidents were a major cause of trauma (motor vehicle injury) in our study probably due to increase population

Table 1: Mean shock index and ammonia levels

Groups	Shock index±SEM	Ammonia levels (umol/L)±SEM
I (*n*=62)	1.28±0.0645**	68.55±1.8**
II (*n*=38)	0.74±0.019	37.55±1.2

**Group I versus Group II *P*<0.01. SEM: Standard error of mean

Table 2: Percentage of patients showing shock index ≥0.9/≤0.9

Groups	≤0.9	≥0.9
I (*n*=62)	11.3**	88.7**
II (*n*=38)	86.9	13.1

**Group I versus Group II *P*<0.01

Table 3: Ammonia levels in patients with complications and mortality in Group I

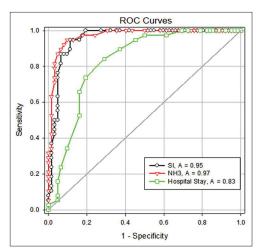| Patients	Ammonia levels umol/L
With complications (*n*=38)	68.5
Without complications (*n*=24)	57.1
Expired patients (*n*=5)	87.4

Figure 1: Receiver operating characteristic analysis of hospital stay, shock index, and ammonia levels

and number of vehicles on the road. Similar cause has been reported by other studies also.[10] A maximum number of patients (78%) were below the age of 40 years suggesting this age group people are more outgoing and rash drivers making them more prone to accidents. In other studies also age incidence was similar.[11] Male preponderance (93%) noted in our study is higher than earlier studies, may be reflecting Indian culture where male member of the family being breadwinner, needs to travel more than females.[12]

The routine evaluation of blunt trauma abdomen patients includes various clinical parameters, physical examination, radiological and laboratory findings. None of the parameters alone or in combination have desirable predictive value at present. Increased ammonia levels as observed in our study could itself be danger signal in these patients as it is sign of blood in abdominal cavity due to blunt trauma. Intestinal bacterial enzymes acting on it produces ammonia which is freely diffusible and moreover liver in not fit for its detoxification as hemorrhage decreases hepatic blood flow through portal vein causing dysoxia of cells.[13,14] Increased ammonia levels have been reported in animal hemorrhagic shock and in few human studies as well.[15,16]

Cutoff value for ammonia was also calculated to maximize sensitivity and specificity in identifying patients requiring intervention. It was found to be ammonia >58.85 μmol/L (sensitivity 77.42% and specificity 93.37%). The purpose of this study was to augment the diagnostic accuracy of routine clinical assessment of such patient.

High ammonia levels in bleeding patients (Group I) correlated well with SI as 88.7% of these patients had SI > 0.9, i.e., having potentially severe trauma requiring immediate treatment. Other workers have also reported similar SI in bleeding patients.[17] Although SI can be useful clinical parameter in acute hemorrhage which depicts severity of situation in heterogeneous patients presented in emergency but it still needs more study in its support to be single reliable parameter.

Ammonia levels correlated well with various complications experienced by patients, during hospital stay. They had higher ammonia levels compared to patients without any complications. Five patients died in Group I had high ammonia levels (87.4 μmol/L) at admission. High ammonia itself is toxic and can cause various complications, so it must be diagnosed and treated as early as possible. Moreover, trauma patient loses lots of valuable time in reaching trauma center, but once reached the hospital, they need to be diagnosed correctly and quickly. Biochemical marker which is time and cost effective such as

ammonia estimation can predict need of intervention in these patients and best treatment can be provided in the golden hour.

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Conflicts of interest

There are no conflicts of interest.

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