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Original Research

Kidney disease improving global outcome for predicting acute kidney injury in traumatic brain injury patients

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Abstract

Aim: To determine the incidence of acute kidney injury (AKI) based on Kidney Disease Improving Global Outcome (KDIGO) criteria in patients with severe traumatic brain injury and to study AKI in relation to risk factors and outcomes.
Method: This trial was a descriptive analytic study on 83 patients with severe traumatic brain injury admitted to Poursina Hospital (Rasht, Iran). The incidence of AKI was determined based on KDIGO criteria over a 12-month period. The correlation of mortality rates, multi-organ failure (MOF), and neurologic outcome to AKI were studied.
Results: Of 83 eligible patients who entered the study, 25.3% ($N = 21$) developed AKI based on KDIGO criteria. Glasgow Outcome Scale on admission was the only risk factor significantly associated with the incidence of AKI ($p = 0.001$). Mortality rates (62% vs. 22.6%, $p = 0.002$) and the occurrence of MOF were significantly higher in patients who developed AKI (23.8% vs. 0% MOF based on Sequential Organ Failure Assessment, $p < 0.0001$; 19% vs. 0% MOF based on Multiple Organ Dysfunction score, $p < 0.0001$). Poor neurologic outcome was observed in 95% and 92% of patients with and without AKI, respectively ($p = 0.674$).
Conclusion: The incidence of AKI among patients with severe traumatic brain injury is striking. The association of Glasgow Outcome Scale with AKI helps to identify patients at a higher risk of developing AKI. Significant rates of mortality and MOF among patients with severe traumatic brain injury and AKI, necessitates consideration of renoprotective measures from the early days of hospital admission.

Keywords: acute kidney injury; brain–kidney crosstalk; KDIFO; traumatic brain injury

1. Introduction

Traumatic brain injury (TBI) is among the leading causes of mortality and morbidity worldwide. Primary and secondary injuries to the brain could lead to hypoperfusion and ischemic insult to non-neurologic organs.

Acute kidney injury (AKI) develops as a result of brain insult or as a consequence of secondary inflammatory or septic reactions. Using drugs with nephrotoxic side effects, such as mannitol for the management of intracranial pressure, may lead to complications like rhabdomyolysis due to trauma which might play a considerable role in kidney injury and should be taken into account.[1]

Several scoring systems are available to use in an intensive care unit (ICU) setting, predicting mortality based on organ failure. Sequential Organ Failure Assessment (SOFA) and Multiple Organ Dysfunction (MOD) scoring systems are implicated in the ICU for assessment of multi-organ failure (MOF). Both systems consist of six components evaluating renal, respiratory, coagulation, neurologic, cardiovascular, and hepatic systems. Based on creatinine levels, scores of renal component range from 0 to 4. Scores of 1 and 2 classify the

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renal insult as a dysfunction and scores of 3 and 4 are indicators of renal failure. The threshold of creatinine which classifies an insult into dysfunction or failure differs between two scoring systems.[2,3]

Many systems have been developed for diagnosing and staging AKI in ICU patients. Acute Kidney Injury Network (AKIN), Risk, Injury, and Failure, and Loss, and End-stage Kidney Disease (RIFLE), and Kidney Disease Improving Global Outcome (KDIGO) are panels with different criteria. AKIN criteria evaluates renal function based on serum creatinine or urine output during 48 hours.[4,5] RIFLE criteria observes the creatinine level and glomerular filtration rate and urine output over a span of 7 days.[6] KDIGO criteria, which was formed in 2012, monitors alterations in kidney function similar to AKIN criteria but within 7 days, similar to that of RIFLE criteria; thus including both previously designed systems.[7]

Although limited studies have been performed, the incidence of AKI among patients with severe TBI has been reported as a variable range with regard to different definitions of AKI.[8,9] Studies of non-neurologic organ failure in patients with TBI reported an incidence of <2% of AKI using SOFA and MOD scoring systems.[3,10–12] Based on different criteria, AKI is estimated to have an incidence of 1.5–23% in a neurotrauma setting[8,10,13,14] and contributes to higher rates of mortality and morbidity[8,15] and poor neurologic outcome.[6]

The aim of this study was to define the incidence of AKI based on KDIGO criteria in patients with severe head trauma, and to evaluate AKI in association with risk factors and outcomes of mortality, neurologic deterioration, and MOF.

2. Materials and methods

The present study was performed as a descriptive analytic trial, after the approval of the Ethics Committee of Guilan University of Medical Science (Rasht, Iran) and gathering informed consent. All patients with severe TBI who were admitted to the neurosurgery ICU of Poursina Hospital from March 2013 to April 2014 were included. Enrolled in study were patients with a TBI (due to traffic accidents) and one of the following conditions: an initial resuscitation (systolic blood pressure > 90 mmHg and arterial oxygen saturation > 90%); Glasgow Coma Score (GCS) of ≤ 8 at ICU admission; a postresuscitation GCS at presentation to the Poursina Neurosurgery ICU of ≤ 8 in the absence of any type of sedation and drug or alcohol overuse; indication for intracranial pressure monitoring; or the presence of a clinical herniation syndrome diagnosed by a neurosurgeon.[16] Excluded from the study were patients with concomitant trauma to the chest, abdomen, or pelvis, that resulted in vital organ damage, patients with a previous history of vital organ involvement, and patients with an unknown past medical history. Acute Physiology and Chronic Health Evaluation (APACHE) II score was calculated for all patients on the 1st day of admission to ICU. During the period of the study, SOFA and MOD scores were calculated daily for all patients based on original guidelines. For any organ compartment, Score 0 was considered normal, Score 1 and 2 represented organ dysfunction, Score 3 and 4 was demonstrative of organ failure, and scores of ≥ 6 represented a state of MOF.[2,3]

Table 1
Definition of acute kidney injury (AKI) based on Kidney Disease Improving Global Outcome (KDIGO) panel.

KDIGO defines AKI as any of the following:
Increase in serum creatinine by ≥ 0.3 mg/dL within 48 h or
Increase in serum creatinine to ≥ 1.5-times baseline within the last 7 d or
Urine output < 0.5 mL/kg/h for 6 h

A daily screening program based on KDIGO panel guidelines for AKI was applied for all patients during the study period (Table 1). For statistical data analysis, SPSS version 21 (SPSS Inc., Chicago. IL, USA) was used. Incidence of AKI defined by KDIGO criteria and frequency of MOF, based on SOFA and MOD scores, were calculated. Fisher's exact test and Pearson's Chi-square test were used to correlate the AKI with risk factors and outcomes of mortality, MOF, and neurologic outcome. In order to report the neurologic outcome, Glasgow Outcome Scale (GOS) was dichotomized into favorable (GOS: 4, 5) and unfavorable (GOS: 1, 2, 3).[8] Multivariable linear regression analysis was used to detect the relationship of risk factors with AKI. All tests were two-sided and $p < 0.05$ was considered to be statistically significant.

3. Results

Of all patients who were admitted to the ICU of Poursina Hospital during the study period, 83 were eligible to enroll. Most of the patients diagnosed with severe TBI were men (93.9%) and were young (mean age: 33 ± 18 years). Mortality rate was 27.7% ($N = 23$) and 79.5% of the study population had shown a poor neurologic outcome (GOS = 1, 2, 3). The incidence of AKI was reported as high as 25.3% ($N = 21$). Basic characteristic features are shown in Table 2.

The only risk factor shown to be significantly related to AKI was GOS on admission ($p = 0.001$). Age, sex, GCS,

Table 2
Basic characteristic features of the study population.

Age (y)	33 ± 18
Sex (M/F)	78/5
GCS on admission	5.9 ± 1.7
GOS on admission	2.4 ± 1.1
MAP on admission (mmHg)	93.2 ± 11.1
APACHE II	14.1 ± 3.8
SOFA score on 1st d of admission	5.5 ± 1.6
MODS score on 1st d of admission	5.4 ± 1.6
Maximum SOFA score during hospital stay (d)	8.4 ± 2.4
Maximum MODS score during hospital stay (d)	8 ± 2.1
Incidence of AKI	25.30% ($n = 21$)
Mortality	27.7% ($n = 23$)
Poor neurologic outcome (GOS ≤ 3)	79.5% ($n = 66$)

AKI = acute kidney injury; APACHE II = Acute Physiology and Chronic Health Evaluation; F = female; GCS = Glasgow Coma Score; GOS = Glasgow Outcome Scale; M = male; MAP = mean arterial pressure; MODS = Multiple Organ Dysfunction Score; SOFA = Sequential Organ Failure Assessment.