Effect of Serum Osmolarity on Prognosis of Traumatic Brain Injury

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ABSTRACT

Introduction: Road traffic accident has been a significant cause of mortality in today's fast paced world. Metabolic and intracranial parameters have affected the outcome of traumatic brain injury. Countless analysis on biomechanical injury and tissue damage has substantiated additional treatment strategies. Laboratory values have been less investigated to predict the outcome of brain injury. **Aims**: This study was done to find out the association between the serum osmolarity with severity of head injury and the outcome in traumatic brain injury. **Methods:** This study was conducted at Department of Neurosurgery, Nepalgunj Medical college, Kohalpur, Banke from July 2020 to June 2021. 106 patients were included in the study. Clinical profile of the patients and calculated plasma osmolarity were monitored daily. **Results**: 106 patients were enrolled with mean age of 39±18.6 and male study population being on the higher side. 62(58.49%) patients with Traumatic Brain Injury accounted for road traffic accident with mild head injury as the commonest presentation. In about 40.57% of the patients osmolarity ranged between 285 to 295 milliosmole/litre with mean osmolarity of 290.99±10.60. There was no significant association between severity of head injury and serum osmolarity (p value=0.45). **Conclusion**: There is no association between the severity of head injury with serum osmolarity.

Keywords: Glasgow Coma Scale, Serum Osmolarity, Traumatic Brain Injury

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INTRODUCTION

The human brain is a blend of a dynamic network of neurons and hormones.[1] Traumatic Brain Injury (TBI) throughout the world is a major cause of mortality and morbidity and a major concern among the young age population.[2] Significant cerebral disturbances occur after TBI with alteration in cerebral hemodynamics leading to chemical, metabolic and immunological changes in besides parenchymal and vascular damages.[1] Injury or dysfunction of hypothalamus and pituitary handles alteration in serum osmolarity in patients with Traumatic Brain Injury.[3] Disturbance of cellular osmoregulation in the brain results in enormity of intracellular sodium and water which is important in maintaining a constant milieu in the Central Nervous System (CNS). As per Balak et al, significant changes were found in serum osmolarity after minor head trauma in comparison to patients with trauma to other parts of the body.[1] Agha et al studied 50 patients with severe or moderate Traumatic Brain Injury, out of which 11 (22%) developed hypernatremia.[4] In a study conducted by Maggiore U et al, 51% of patients with severe head injury developed hypernatremia. Hypernatremia, a component of cerebral edema which may be iatrogenic also, affects osmolarity.[5] Cerebral edema leads to intracranial hypertension which plays a significant role in the prognosis of patients with Traumatic Brain Injury.[6] Glassgow Coma Scale has been a strong predictor of the outcome of the severity of head injury.[7] Laboratory values have been less investigated to predict the outcome of Traumatic Brain Injury.[8]

METHODS

This is a hospital-based cross-sectional descriptive study conducted at the Department of Neurosurgery, Nepalgunj Medical College, Kohalpur, Banke, Nepal over a period of one year (July 2020 to June 2021). Informed consent from the patients or patient's relatives and approval from Institutional Review Board (IRB) was obtained.

Clinical profile of the patients including laboratory values of Sodium (Na+), Potassium (K+), Random Blood Sugar (RBS) and Urea were monitored daily during their hospital stay. A form was issued with a set of Questionnaires to collect data. Serum

Osmolarity was calculated using the formula, Osmolarity = 2Na+ 2K + urea +RBS. The normal value of serum osmolarity taken for the study ranged from 275 to 295mosm/kg.

(GCS) interpretation as mild head injury (GCS=13-15), moderate head injury (GCS=9-12) and severe head injury (GCS=3-8).

Inclusion Criteria:

- Patients with TBI with mild, moderate and severe forms.

Exclusion criteria:

- Patients with chronic medical disease specially causing electrolyte abnormalities e.g., chronic renal failure, hypertensive using hydrochlorothiazide.
- Patients on steroids for any reason and carbamazepine as an antiepileptic.
- Patients taken to Higher Centre for further Neurosurgical evaluation.

Statistical Analysis

The data entry was done in Microsoft Excel 2019 MSO (Version 2021 Build 16.0.14827.20158) 64- bit. The data were analyzed using the Statistical Program for Social Science (SPSS) for Windows (version 26). The Chi-square test was used to study the difference between age, sex, the severity of the head injury and mode of injury in patients with normal and abnormal osmolarity and the outcome of TBI. A P-value of less than 0.05 was considered statistically significant.

RESULTS

Our study population included a total of 106 patients with ages ranging from 2 years to 79 years with a mean age of 39±18.6. In our study, the majority of males belonged to the age group between 21 to 40 years with the female age group ranging between 41 to 60 years.

Among all the age groups, road traffic accident (RTA) was the most common mode of Traumatic Brain Injury consisting of 62(58.49%) patients, followed by fall from height consisting 27(25.47%) and physical assault 14(13.21%) as shown in figure 1. As shown in Figure 2, a maximum number of patients presented with mild head injury with GCS from 13/15 to 15/15. In our study, in about 40.57% of the patients with TBI, osmolarity ranged between 285 to 295 mosm/l, in 36.79% of patients above 295 mosm/l and in 22.6% below 285 mosm/l with mean osmolarity of 290.99±10.60. The severity of head injury in relation to serum osmolarity is shown in figure 3. According to our study, there is no significant association between sex, the severity of the head injury, age interval, mode of injury and serum osmolarity. (p value=0.50,0.45, 0.29 and 0.53 respectively).

SEX		AGE DISTRIBUTION			
Male	Female	0-20	21-40	41-60	61-80
75 (70.75%)	31 (29.25%)	17 (16.04%)	42 (39.62%)	31 (29.25%)	16 (15.09%)
Total Participants: 106					

Table I: General Characteristics of Patients

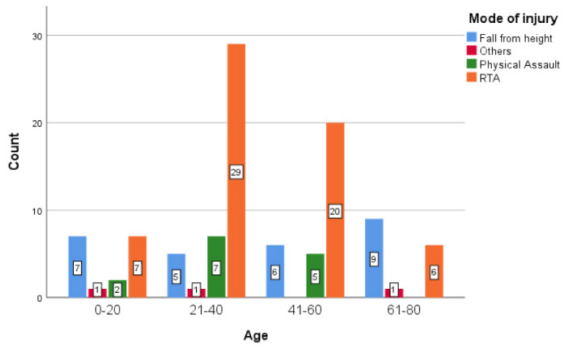

Figure 1: Clustered Bar Count of Age by Mode of Injury

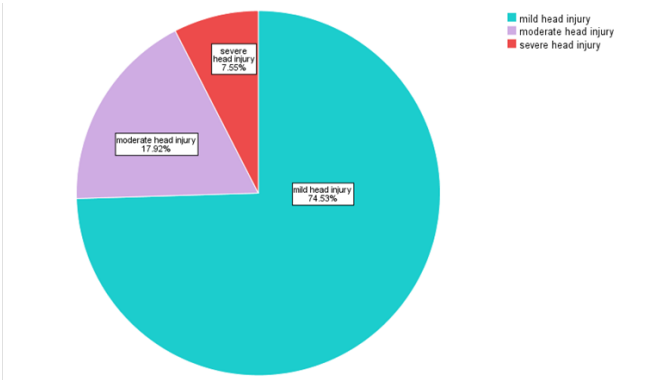

Figure 2: Severity of Head Injury

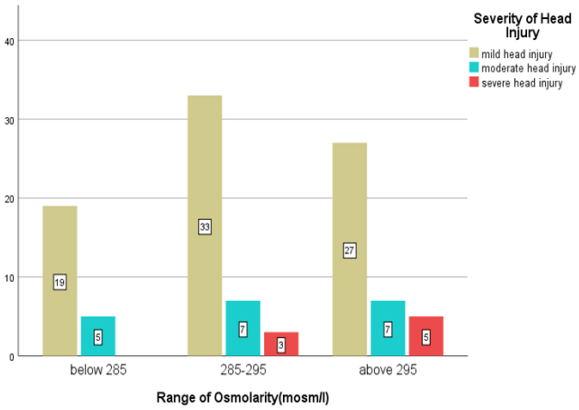

Figure 3: Severity of Head Injury in relation to Serum Osmolarity

DISCUSSION

In this prospective study, we aimed to evaluate changes in between severity of the head injury and serum osmolarity. Although a single blood analysis of serum osmolarity may not show any significance in an individual patient, serum osmolarity monitoring of patients with minor head trauma may be a cost-effective way to help identify those at greater risk.[1] TBI accounts for 1% of all adult deaths with its exceeding impact on the country's health.[3] Also to the high mortality, approximately 60% of survivors have significant ongoing deficits including cognitive competency, major activity, and leisure and recreation.[10] In TBI, heterogenicity exists between etiology, severity, and outcome. It is well known that direct brain trauma

causes complex hormonal responses of the pituitary end-organ axis.[11] Inflammatory and neurotoxic processes within the brain result in the accumulation of vasogenic fluid which is directly related to raised ICP, thus affecting the severity of brain injury.[7] Water and Osmotic imbalance occurs due to edema related structural damage induced by primary injury, which itself is a consequence of initial physical insult.[9] Increasing Osmolarity has an antagonistic action on the outcome of the severity of the head injury which can be a potential risk for death.[8] Trauma to the brain results in injury to the hypothalamus and pituitary stalk. This results in damage to the ADH secretion released by the posterior pituitary which ultimately leads to cerebral Salt Wasting and thus edema formation and change in serum osmolarity.

Our study concluded that significant relation was not seen between Sex and Age Interval with Serum Osmolarity (P value=0.50,0.29 respectively) which is deviant from the study conducted by Naci Balak, M.D. and et al.[1] Increase in Osmolarity has been linked to an unfavorable outcome in the severity of brain injury as shown by a study done in Karolinska University Hospital.[8] In a study done by A. Helmy et al hypoglycemia has been shown to independently worsen survival after TBI.[3] However, a significant negative correlation was found between Serum Osmolarity and intra cranial pressure which itself is a predictor of severity of head injury from the study done by Hayden White and et al.[6] By our study, a significant association was not seen between Severity of Head Injury and Serum Osmolarity (P value=0.45) which has been favored by Hayden White and et al. Regardless of multiple studies showing a significant link between the severity of the head injury and serum osmolarity, our study concludes to be an exception which might be due to various limitations.

LIMITATIONS

Every study has its own limitations and drawbacks. In our study, the sample size was small. As our hospital is a primary neurosurgical care Centre in peripheral Nepal, patients were followed only during their hospital stay as most of the patients were taken to other higher centers for further evaluation. For this reason, we were not able to comment on long-term neurological outcomes or mortality.

Serum Osmolarity in our study was a calculated value rather than an actual measurement of osmolarity using an osmometer. Change in serum osmolarity after head trauma could be detected earlier than other potential serum biomarkers. The role of urinary osmolarity and anti-diuretic hormone (ADH) has been found to be of significance to indicate the osmolarity disturbances in minor or mild TBI. We were limited by clinical and technical difficulties and the results might have been better if we were able to measure urine osmolarity and ADH.

CONCLUSION

There is no association between the severity of head injury with serum osmolarity.

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