Original Article

Evaluation of Serum Calcium Levels in a Cohort of Head Injured Patients: A Prospective Observational Study

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ABSTRACT

Objectives: Serum calcium abnormalities in head injury can result in a number of clinical manifestations which may worsen outcome. The serum level of calcium is not routinely measured in head injured patients in our country. This study aims to determine the incidence of deranged serum calcium level in a cohort of head injured patients in Nigerian and relate this to injury severity and management outcome

Materials and Methods: This was a prospective observational study of head injured patient who presented at our center within 24 hours of trauma during the study period. Clinical and demographic characteristics as well as admission serum calcium levels were analysed using the Statistical Package for the Social Sciences (SPSS). The outcome measures were serum calcium levels and management outcome. A p-value less than 0.05 was considered as statistically significant.

Results: There were 114 patients in the study, 89 males and 25 females (M:F- 3.7:1). The mean age was 31.2±15.8 years. Head injury was severe in 18.42% of the patients, moderate in 22.81% and mild in 58.77% (Table 1). The serum calcium ranged from 6.60-10.42mg/dl with a mean of 8.62±0.83mg/dl. Serum calcium level was normal in 55.26% of the cases, and low in 44.74% (Fig. 2). There was no correlation between serum calcium level and severity of injury (p=0.667) or outcome of head injury (p=0.973) in this study.

Conclusion: Derangement in admission serum calcium was common in our patients with almost half of our patients presenting with hypocalcaemia. However, there was no correlation between serum calcium level and severity of injury or outcome of head injury in this study.

INTRODUCTION

Traumatic brain injury (TBI) poses a major health and socioeconomic problem throughout the world today.[1] It affects mainly the economically productive age groups with consequent staggering economical loss due to cost of acute care, rehabilitation and lost productivity. The economic burden of TBl is staggering, with per-patient hospital costs for patients with severe disease (42% of those hospitalized) running as high as $33,000 in United

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States of America.[2] Although there is paucity of information on similar figures in Nigeria, the impact of head injury is no less crippling as suggested by reports from workers in the field in local populations.[3,4] Whereas little can be done about primary brain injury, secondary injuries are preventable thereby potentially modifying the outcome. Some of the causes of secondary head injury include expanding intracranial haematomas, hypoxia, hypotension, deranged blood sugar levels, hydrocephalus, seizure, infection and electrolyte imbalance. Although the most common electrolyte derangement in head injury is deranged sodium level and then potassium, deranged serum calcium, phosphate and magnesium have been described.[5,6,7,8,9] Following head injury, derangements in the serum calcium level of up to 17.1-64% have been reported.[5,6,8] Serum calcium abnormalities in head injury can result in a number of clinical manifestations including tetany and seizures.[6,9] Documented evidences have pointed to the involvement of calcium in the pathophysiology of induced neuronal death.[10,11] Reduced intracellular calcium results in cell death through activation of caspases and apoptotic pathways.[12,13] Hypocalcaemia has been reported to be an indicator of the degree of brain damage resulting from several pathologic mechanisms including direct mechanical trauma, hypoxia, neuro-inflammation and disrupted vessel auto-regulation following head injury.[12] While serum levels of sodium, potassium, chloride and bicarbonate are routinely measured in the head injured patients, the level of calcium is not despite it roles in the pathophysiology of secondary brain injury and potential effect on the outcome of head injury. This is especially so in the developing countries.[5,8] There is dearth of published data on the level of serum calcium among head injured patients in sub-Saharan Africa, and to the best of our knowledge none from our country. This study aimed to determine the incidence of deranged calcium level in a cohort of head injured patients in Nigeria and relate this value to injury severity and management outcome.

MATERIALS AND METHODS

This was a prospective observational study of head injured patients who presented at our center within 24 hours of trauma between January and December 2018. The patients who presented after 24 hours, pregnant patients, patients with hypertension, endocrine disorders and those on diuretics were excluded. All the patients in the study were treated according to the standard treatment protocols for managing head injuries at our facility. Serum calcium, serum albumin and corrected serum calcium levels were measured at the time of admission. The normal reference range for calcium is 8.5-10.5mg/dl. Levels outside this range were considered as deranged calcium levels. The Glasgow Coma score was used to determine the injury severity while management outcome was assessed using the Glasgow outcome score. The patients were followed-up till discharge, death, or for a maximum of one month of hospital admission. Glasgow outcome scores of 4 and 5 (moderate disability and good recovery) were classified as good outcome while scores of 1, 2, and 3 (death, vegetative state, and severe disability) were classified as poor outcome. Statistical analysis was done with the Statistical Package for the Social Sciences (SPSS) version 20 (SPSS Science Inc., Chicago, IL, USA). The Pearson Chi square was used to evaluate the association between serum calcium level and the severity as well as the outcome of head injury. A p-value less than 0.05 was considered as statistically significant.

RESULTS

A total of 114 patients were included in the study. There were 89 males and 25 females (M: F- 3.7:1). The age ranged from 1-76 years with a mean of 31.2±15.8 years. The age groups 20-59 accounted for 63.15% of the cases (Fig. 1). Head injury was severe in 18.42% of the patients, moderate in 22.81% and mild in 58.77% (Table 1). The serum calcium ranged from 6.60-10.42mg/dl with a mean of 8.62±0.83mg/dl. Serum calcium level was

normal in 55.26% of the cases, and low in 44.74% (Fig. 2). Hypercalcaemia was not seen in this study. The outcome was worst in patients with severe head injury (Table 2). There was no correlation between serum calcium level and severity of injury in this study (p=0.667) (Table 3). We also did not find significant association between serum calcium level and outcome of head injury either in the general patients' population (p=0.973) (Table 4) or in the subset of our patients with severe head injury (p=0.896) (Table 5).

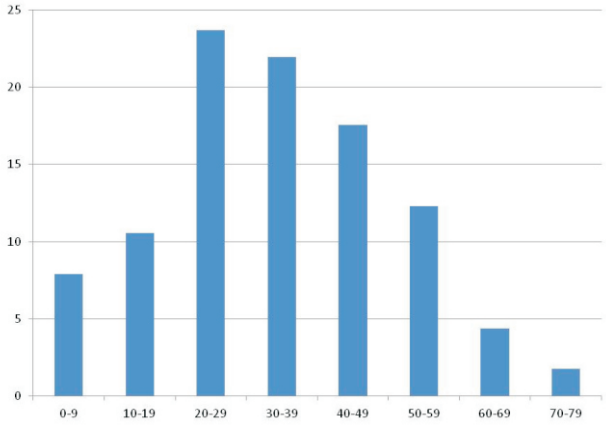

Fig. 1: Age distribution of the patients in percentages

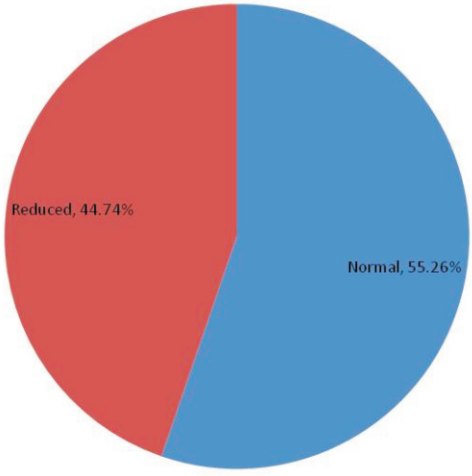

Fig. 2: Proportion of serum calcium levels

Table 1- Demographic and clinical characteristics of the patients

	Total N=114
Age, Mean (SD)	31.2 (15.8)
Gender, N (%)	
Male	89 (78.07)
Female	25 (21.93)
Severity, N (%)	
Severe	21 (18.42)
Moderate	26 (22.81)
Mild	67 (58.77)
Calcium, Mean (SD)	8.62 (0.83)

Table 2: Outcome in various categories of head injury

Outcome	Mild head injury N (%)	Moderate head injury N (%)	Severe head injury N (%)
Good recovery	61 (91.04)	13 (50.0)	6 (28.57)
Moderate disability	2 (2.99)	9 (34.61)	2 (9.52)
Severe disability	0 (0.0)	1 (3.85)	1 (4.76)
Vegetative	0 (0.0)	0 (0.0)	0 (0.0)
Death	4 (5.97)	3 (11.54)	12 (57.14)

Table 3: Correlation between serum calcium levels, severity of head injury and outcome

		Normal Calcium N (%)	Reduced Calcium N (%)	p-value
Severity				
	Severe	10 (15.87)	11 (21.57)	0.667
	Moderate	13 (20.64)	13 (25.49)	
	Mild	40 (63.49)	27 (52.94)	
Outcome				
	Good	52 (82.54)	41 (80.39)	0.973
	Poor	11 (17.46)	10 (19.61)	
Mortality				
	Yes	10 (15.87)	9 (17.65)	0.728
	No	53 (84.13)	42 (82.35)	

Table 4: Outcome in general study population with normal and reduced serum calcium levels

Outcome	Normal Calcium N (%)	Reduced Calcium N (%)	p-value
Good recovery	46 (73.01)	36 (70.59)	0.973
Moderate disability	6 (9.52)	5 (9.80)	
Severe disability	2 (3.18)	0 (0.0)	
Vegetative	0 (0.0)	0 (0.0)	
Death	9 (14.29)	10 (19.61)	

Table 5: Outcome in the severe head injured patients with normal and reduced serum calcium levels

Outcome	Normal Calcium N (%)	Reduced Calcium N (%)	p-value
Good recovery	4 (40.0)	2 (18.18)	0.896
Moderate disability	0 (0.0)	2 (18.18)	
Severe disability	1 (10.0)	0 (0.0)	
Vegetative	0 (0.0)	0 (0.0)	
Death	5 (50.0)	7 (63.63)	

DISCUSSION

Several electrolyte derangements with notable effects on the clinical outcome have been reported in head injured patients. These abnormalities include hyponatraemia, hypernatraemia, hypokalaemia, hypocalcaemia, hypomagnesemia and hypophosphataemia.[14,15,16,17,18] Some of the proposed mechanisms responsible for these derangements include syndrome of inappropriate secretion of antidiuretic hormone, cerebral salt wasting and increase in intracellular levels of electrolytes.[19,20,21] Mannitol administration in head injured patient may also be a contributing factor to the electrolyte derangements seen in this population.[18] While serum levels of some these electrolytes are routinely measured in head injured patients in our environment, others are rarely if ever measured. We evaluated the serum calcium levels within 24 hours of trauma in a cohort of head injured patients in Nigerian. There were 114 patients in this study, 89 males and 25 females (M:F- 3.7:1). The demographic and clinical characteristics of these patients (Table 1) are in accordance with the reports in local and foreign literature.[3,4,22,23]

Serum calcium changes, hypocalcaemia or hypercalcaemia, can result in a variety of clinical manifestations in patients with head injury including tetany and seizures.[9,24] These are due to abnormal responses of neurons to stimulation secondary to accumulation of intracellular calcium in traumatic brain injury.[25] The serum calcium was deranged (hypercalcaemia and hypocalcaemia) in 44.74% of the patients in this study (Fig. 2). This figure is more than the 17.1% reported by Suman *et al* and the 37.7% reported by Rafik *et al* but less than 64% in the study by Gupta *et al*.[5,6,8] Similar to the series by Gupta *et al* there was no case of hypercalcaemia in this study.[8] The predominance of hypocalcaemia was also reported by Suman *et al*, Rafik *et al*.[5,6] The incidence of hypocalcaemia in our study is higher than the 11.4% in the series by Suman *et al* and the 33% reported by Rafik *et al*.[5,6]

A statistically significant association between serum calcium and severity of injury has been described.[5] However, there was no association between severity of injury and the serum calcium level in this study (p=0.667). Similarly, we did not find any association between serum calcium level and outcome of head injury in this series (p=0.973) though a strong association exists between severity of head injury and outcome (p= <0.001) (Table 3). In a review by Vinas-Rios *et al*, hypocalcaemia on the third day of trauma was shown to correlate with poor outcome in patients with moderate and severe head injury.[12] The lack of association between serum calcium level and outcome of head injury in our study may be due to a small sample size or the fact that only serum calcium level within 24 hours of trauma was evaluated.

In our country ,like in many other low and low-middle income countries which most sub-Saharan African countries belong to, health care is still largely privately funded by individuals.[26,27] This privately funded/out-of-pocket payment model of health care financing, on a background of poverty endemic in these settings, ensures that the health care givers have to sometimes prioritize investigations and even treatment modalities. Therefore, while the serum levels of sodium and potassium are routinely measured at admission in head injured patients in our environment, the serum level of calcium is not and thus derangements in the level of calcium may remain undetected for prolonged period or not at all. All people caring for head injured patients should be aware of the possible existence of deranged serum calcium and the risks posed by same in this group of patients. We recommend routine and possibly serial measurement of serum calcium in head injured patients. Further research is required to determine the trend in the serum calcium level in the acute phase of traumatic brain injury in our environment and to correlate these levels to outcome.

CONCLUSION

Derangement in serum calcium occurred in almost half of our patients. There was no hypercalcaemia in our study. However, there was no correlation between serum calcium level and severity of injury or outcome of head injury in this study.

Conflict of interest

The *authors report no conflicts of interest*

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