ORIGINAL RESEARCH

Hyponatremia In Post Operative Patients Despite Giving Isotonic Saline

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ABSTRACT

Introduction: In health amounts of water and electrolytes in the body are maintained with in relatively narrow limits. Diseases, injuries and even operative trauma impose a great impact on physiology of fluid and electrolytes within the body. Hence in the present study we aim to study the occurrence of hyponatremia in patients 24 hrs after surgery, patients were administered isotonic saline postoperatively to evaluate the mechanisms responsible for hyponatremia in this setting.

Material and Methods: Plasma electrolyte levels were measured in 100 patients admitted for elective surgery, at the time of induction of anaesthesia and 24 hours after surgery. Data on the balance of water and electrolytes was also obtained during this 24-hours period postoperatively.

Results: Before induction of anaesthesia, the plasma sodium concentration was 137.11 ± 5.7 mEq/ L; 24 hours later, it decreased significantly to 131.89± 6.3 mEq/ L ($p<0.001$). The urine was hypertonic in all patients for the first 8 hours after induction of anaesthesia.

Conclusion: Postoperative hyponatremia occurred within 24 hours of induction of anaesthesia despite of giving isotonic fluids. Hyponatremia was due to electrolyte-free water retention in addition to excretion of hypertonic urine. This electrolyte-free water was retained in the body because of the actions of antidiuretic hormone. If the pathophysiology of this hyponatremic state is understood, recommendations for its prevention and treatment can be deduced.

Keywords: Electrolytes, Hyponatremia, Plasma

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Conflict of Interest: None

INTRODUCTION

Na^+, K^+, $Cl^-$and $HCO3^-$ are the major electrolytes that play an important role in maintenance of osmotic pressure, water distribution, pH, heart and muscle function, redox reactions and catalysis as cofactors for enzymes. Abnormal levels of electrolytes can be either a cause or consequence of variety of disorders thus indicating the importance of measurement of this electrolytes.[1] In health amounts of water and electrolytes in the body are maintained with in relatively narrow limits by kidney which in turn acts under the influence of hormones and other factors.[1] One of the most critical aspects of patient care is management of body composition of fluids and electrolytes. Diseases, injuries and even operative trauma impose a great impact on physiology of fluid and electrolytes within the body. Both prospective and retrospective studies have demonstrated the presence of symptomatic hyponatremia in around 20 % of post operative cases leading to death or serious brain damage.[2,3] Small increase in brain volume (> 5%) can lead to sustained morbidity and mortality.[2] Thus every effort must be made to prevent development of brain swelling from hyponatremia. Postoperative hyponatremia is a preventable cause of illness and death. If the pathophysiology is understood, recommendations for its prevention and treatment can be deduced.[3]Hence in the present study we aim to study the occurrence of hyponatremia in patients 24 hrs after surgery and to evaluate the mechanisms responsible for hyponatremia.

MATERIALS AND METHODS

After obtaining permission from institutional ethics committee, a total of 100 patients between age group of 20–70 years who were admitted for either elective or emergency surgery in the department of surgery Osmania medical college and hospital were selected for the present study. Cases were selected at random and patients with any history of renal, liver, cardiac pathology, diabetes and patients on diuretics were excluded from study. Patients consent was taken and

5ml of heparinized venous blood samples was collected preoperatively at the time of induction of anaesthesia and at 24 hrs after surgery. Plasma was separated within 30mins. Plasma sodium, potassium and chloride levels were measured by flame photometry. Plasma glucose by GOD- POD, plasma urea by DAM method and plasma creatinine was estimated by jaffe's alkaline picrate method.

Patients were on NBM for 24 hrs post operatively, total fluid input and output was measured during 24 hrs. Urine samples were collected after 8 hrs and 24 hrs postsurgery urinary Na^+ and k^+ levels were estimated after dilution. For urine sodium measurement, urine was diluted 1:50 and for measurement of urine potassium, the urine was diluted for 1:500 and the diluted samples were estimated by flame photometry.[17]

RESULTS

Out of the 100 cases 88 cases had lower post operative plasma sodium concentration with in 24 hrs after surgery. The difference ranging between 1 to 10 mEq/ L from the mean. There was a significant ($p<0.001$) decrease in plasma sodium concentration post operatively (131.89 mEq/ L) compared to preoperative levels (137.1 mEq/L). The mean concentration of potassium before anaesthesia was 4.2 mEq/L and after anaesthesia 3.9 mEq/L, there was a significant decrease in plasma potassium value post operatively $p< 0.001$. There was a significant increase in the plasma glucose levels post operatively $p <0.01$. However there was no significant difference ($p>0.05$) in the mean chloride, bicarbonate, urea and creatinine pre and post operatively.

Preoperative body weight was recorded in all patients and positive balance for electrolytes was calculated using following assumptions.

a. Preoperative total body water was 50 % of the body weight and intracellular fluid volume was $2/3^{rd}$ of body water (i.e. 55% in females and 60% in males.
b. Number of particles in intracellular fluid did not change.

Effective osmolality was calculated by using the formula = 2 x Na^+ x total body water.

From this total body water after surgery was calculated the difference between these two was taken as gain in electrolyte free water.

Total average input was 3.4 L total fluid output 1.7L average sodium input was 370.3 and average excretion was 134.11. The potassium input was 7.15 mEq/day and excretion was 12.15 mEq/day. Net electrolyte balance was 231.19 mEq/day.

The decrease in sodium concentration between males and females was compared it was observed that there was no significant decrease in mean sodium concentration post operatively between males and females, however the decrease in potassium concentration was significantly more in males compared to females.

Table-1: Mean± SD of parameters before and after anaesthesia

Parameter	Before anaesthesia	After anaesthesia	P value
Sodium (mEq/ L)	137.11 ± 5.7	131.89 ± 6.3	<0.001
Potassium (mEq/ L)	4.2 ± 0.7	3.9 ± 0.63	<0.001
Chloride (mEq/ L)	104.5 ± 5.9	103.9 ± 4.9	>0.1
HCO3 (mEq/ L)	23.5 ± 1.9	22.6 ± 2.88	>0.1
Glucose mg/dl	82.14 ± 12.97	88.7 ± 11.6	<0.01
BUN mg/dl	13.02 ± 2.6	12.78 ± 1.48	>0.1
Creatinine mg/dl	0.82 ± 0.25	0.79 ± 0.16	>0.1

Table-2: Electrolyte and water balance

Fluid	**Water (lts)**	**Sodium mEq/ day**	**Potassium mEq/ day**
Infused	3.4	370.3	7.15
Excreted	1.7	134.11	12.15
Balance	+ 1.7	+ 236.19	-5.0

Table-3: Change in electrolyte composition

	Males	**Females**	**P value**
Decrease in Na concentration	6.815 ± 5.44	5.33 ± 3.45	>0.1
Decrease in K concentration	0.325 ± 0.14	0.23 ± 0.14	<0.001

DISCUSSION

Hyponatremia is claimed to be the most common electrolyte disorder encountered in hospitalized patients, resulting from different pathophysiological mechanisms. Postoperative hyponatremia is prevent-able cause of illness and death. The present study is undertaken to evaluate postoperative hyponatremia. Several authors have reported hyponatremia during the postoperative period.[3-5] In the present study it is observed that there was a decrease in serum sodium concentrations 24 hrs after surgery compared to

preoperative concentrations in 88 % of the patients studied. This decrease was statistically significant. Postoperative hyponatremia is attributed to two factors, firstly excessive amounts of electrolyte free water infusion and secondly the actions of antidiuretic hormone preventing the excretion of electrolyte free water. In this study the postoperative cases in whom all the infusions made are of near isotonic saline. Hence the role of infusion of excessive electrolyte free water is excluded. In order to assess the cause for hyponatremia the electrolyte free water retention was calculated. The present study shows positive average fluid balance positive sodium balance and negative potassium balance. Primary water retention and early sodium retention in first 24 hrs postoperative period was reported earlier. In the present study it was found that on an average 1.2 L of electrolyte free water is gained during first 24 hours postoperative period and the remaining 0.5 L gain was due to isotonic saline. Hence the ultimate cause for hyponatremia in post operative patients is retention of electrolyte free water. As the possibility for electrolyte free water through infusion is excluded, the other possibility is kidney. For the kidney to generate electrolyte free water the urine must have high concentrations of sodium and potassium. The present study shows excretion of sodium and potassium in the urine during 24 hrs post operative period. It is found that all urine samples are hypertonic during the first 8 hrs (Na^+ + K^+ more than 150 mmol/ L).[4] The elaboration of hypertonic urine is also an evidence for prevention of excretion of electrolyte free water by kidneys by the action of antidiuretic hormone. An elevated plasma level of antidiuretic hormone is essentially universal postoperative occurrence in initial 2– 4 postoperative days.[6-8] The release of antidiuretic hormone was not triggered by the physiologic stimuli of hyper tonicity or of low effective circulation volume but could present a response to any combination of pain, drugs, stress or nausea. If the cause of postoperative hyponatremia is only electrolyte free water retention, the concentrations of other analytes should also be diluted to the same extent. In the present study no statistically significant decrease in concentrations of bicarbonate, urea, creatinine and chlorides are observed except for sodium and potassium. Significant increases in the blood glucose values are observed. This indicates that, electrolyte free water accumulation and resulting dilution is not the only pathophysiologic mechanism involved in the post operative hyponatremia. Recent studies have shown that at least three factors which are not appreciated earlier appear to influence electrolyte homeostatsis in hyponatremia. Firstly the ability of ADH per se to effect electrolyte homeostasis, secondly hyponatremia may stimulate release of ANP. Thirdly hypotonic state induces cellular volume regulatory responses which promote ion shifts leading to altered fluid distribution and electrolyte concentrations. These factors might explain the unaltered concentrations of other analytes studied vis bicarbonate, urea and creatinine. Different studies have shown increases, no change and decrease in serum potassium concentrations and attributed these changes to different causes like administration of diuretics. In the present study we observed significantly decreased serum potassium concentrations and a negative potassium balance. This negative potassium balance is also observed in experimental hyponatremic animals.[9] It has been shown that the nature of anion associated with excreted potassium indicates the origin of potassium.[10] Excretion with phosphates indicates intracellular origin.[10] The negative potassium balance and decrease in anion gap (decreased unmeasured anion in the presence of unaltered chloride) may indicate the origin of potassium lost being intracellular. This finding supports the redistribution of electrolytes. The kaliuresis may be due to the new known character of ADH in augmenting potassium secretion by the cortical and medullary collecting ducts.[11-13] Many studies have shown significant decreases in chloride concentrations in hyponatremia.[10] In the present study the mean chloride concentration though low are not significantly decreased the present study could not explain this finding except that the anion excreted in association with cation could be other than chloride. It has been shown that trauma and stress increases blood glucose values. In our present study there was a significant increase in blood glucose values which could be due to trauma and stress. In the present study there was no significant difference in the mean serum sodium concentrations between men and women, this study agrees with earlier report[4.14] that women and men are equally likely to develop hyponatremia post operatively. However symptomatic hyponatremia can lead to greater incidence of complication in women as a result of smaller fluid volume and sex related hormonal factors.[15,16]

CONCLUSION

Postoperative hyponatremia occurred within 24 hrs of induction of Anaesthesia despite giving isotonic fluids. Hypernatremia was due to retention of electrolyte free water in addition to excretion of sodium and potassium in the urine. Retention of electrolyte free water was due to elevated ADH in response to pain, drugs, stress and nausea. If the pathophysiology of this hyponatremic state is

understood, recommendations for its prevention and treatment can be deduced.

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