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Research Article

Serum electrolyte changes in major surgical trauma

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ABSTRACT

Background: Operative trauma is followed by a series of changes collectively referred to as metabolic response to injury, the magnitude and duration of the response being directly proportional to the severity of the trauma. Operative trauma imposes a great impact in the physiology of fluid and electrolytes within the body. Fluid and electrolyte management has thus been an integral part of care of each and every surgical patient. In the present study, an attempt has been made to study the electrolyte changes, especially that of sodium and potassium following surgical trauma due to various surgical procedures and its implication in the principles of replacement therapy.
Methods: The present study is being carried out in 50 surgical patients both male and female, of age group of 18-70 years. Serum electrolytes (Na, K, Cl, Ca and Mg) of each patient was estimated one day before operation (-1), on the day of operation (0) after surgery, next consecutive 4 postoperative days (+1, +2, +3, +4) and on 7th postoperative day (+7).
Results: There occur a fall in serum sodium and chloride level on the day of operation in all cases which attain a still lower level in 1st postoperative day. Then from 2nd postoperative day onwards, there occur a gradual rise and attain preoperative value by 4th postoperative day in most cases and by 7th postoperative day in all cases. There occurs an elevation on serum potassium level from the day of operation, which becomes highest in 1st postoperative day. This follows a gradual fall in from 2nd postoperative day onwards and attains preoperative level in most cases by 4th postoperative day and in all cases by 7th postoperative day. Serum calcium and serum magnesium showed a constant serum level throughout the study period.
Conclusion: There was tendency of the body to conserve sodium, chloride on the day of operation and on 1st postoperative day, while potassium is excreted from body in these days. From postoperative day onwards the trend started to attain preoperative values and completed by day 4 postoperatively. The changes in serum electrolytes were directly proportional to degree of tissue trauma or tissue handling.

Key words: Trauma, Electrolytes, Potassium, Sodium

INTRODUCTION

The inorganic electrolytes i.e. sodium, potassium, chloride, calcium etc. are important constituents of body fluid as they play a vital role in cellular function and survival, in regulating fluid balance in respective zones, excitability of tissues and acid base equilibrium and other manifestations associated with life.[1] Changes in both fluid volume and electrolyte composition occur preoperatively, intraoperatively and postoperatively.[2] Operative trauma imposes a great impact in the physiology of fluid and electrolytes within the body, which is greater than the changes associated with a simple lack of alimentation. Apart from blood loss, there is sequence of events consisting of increased loss of fluid through lungs along with pooling of plasma and ECF in

the operative site. In addition to these immediate effects, operative trauma is followed by a series of changes collectively referred to as Metabolic response to injury, the magnitude and duration of the response being directly proportional to the severity of the trauma.[3,4] Moore's metabolic care of the surgical patients is a milestone in the field of modern surgery.[5] A successful post-operative result depends, therefore, upon the individual need and on the totality of physiological and biochemical response that come into play when surgery distorts normal pattern. Surgical care is based not the abrogation of such response (interference) but rather on an understanding of the normal adaptation and to treat it when abnormal.[6,7] Fluid and electrolyte management has thus been an integral part of care of each and every surgical patient.[8] In the present study, an attempt has been made to study the electrolyte changes (sodium, potassium, chloride, calcium and magnesium) following surgical trauma due to various surgical procedures and its implication in the principles of replacement therapy.

METHODS

The study was conducted (with Institutional Ethical Committee approval) in 50 patients in the Department of Biochemistry of Rajendra Institute of Medical Sciences, Ranchi. The cases were selected among indoor patients in the Department of Surgery, RIMS to study the electrolytes changes occurring in serum after surgical trauma. Patients having apparently no other pathology except for which they were operated and without clinical manifestations of deranged fluid and electrolyte balance were selected. Serum electrolytes (Na, K, Cl, Ca and Mg) of each patient was estimated one day before operation (-1), on the day of operation (0) after surgery, next consecutive 4 postoperative days (+1, +2, +3, +4) and on 7th postoperative day (+7). 3.0 mL of blood was collected from all the subjects and electrolyte(Na^+, K^+, Ca^{2+} and Cl^-) were analyzed in ion selective Electrode, ecolyte (Eschweiler, Germany). Magnesium Estimation was done by Calmagite method. All the samples were analyzed on the same day or kept at -20 ^{0}C to be analyzed within next two days.

RESULTS

Table 1: Cases studied with number of patients.

Degree of tissue injury	Male	Female	Total number
Major	12	22	34
Minor	11	5	16
Total	23	27	50

Table 2: Observation on changes of serum sodium, potassium and chloride levels in the postoperative period (average value).

Day of surgery	Average value of serum (meq/L)				
	Sodium	Potassium	Chloride	Calcium	Magnesium
-1	140.3	4.02	100.12	1.30	1.86
0	131.4	4.64	92.70	1.31	1.88
+1	122.8	4.98	89.76	1.28	1.84
+2	132	4.69	93.36	1.30	1.80
+3	136.3	4.37	96.78	1.32	1.86
+4	140.2	4.12	99.9	1.29	1.84
+7	141.3	4.11	101.7	1.31	1.88

Table 3: Observations on effect of degree of tissue trauma on serum electrolytes.

	Days → ↓type of tissue trauma	-1	0	+1	+2	+3	+4	+7
Avg. serum Na^+ (meq/L)	Major tissue trauma (n=34)	141.0	131.01	119.7	131.4	136.3	140.7	142.2
	Minor tissue trauma (n=16)	138.8	132.2	129.4	133.1	136.3	139	139.3
Avg. serum K^+ (meq/L)	Major tissue trauma (n=34)	3.99	4.74	5.12	4.79	4.3	4.1	4.13
	Minor tissue trauma (n=16)	4.08	4.42	4.68	4.47	4.23	4.11	4.06
Avg. serum Cl^+ (meq/L)	Major tissue trauma (n=34)	100.64	92.13	88.65	92.7	96.5	100.18	102.5
	Minor tissue trauma (n=16)	99	93.9	92.1	94.7	97.2	99.3	99.8
Avg. serum Ca^{2+} (meq/L)	Major tissue trauma (n=34)	1.30	1.31	1.28	1.30	1.32	1.29	1.31
	Minor tissue trauma (n=16)	1.30	1.32	1.27	1.30	1.32	1.28	1.30
Avg. serum Mg^{2+}(meq/L)	Major tissue trauma (n=34)	1.86	1.88	1.84	1.90	1.86	1.84	1.88
	Minor tissue trauma (n=16)	1.86	1.88	1.86	1.90	1.86	1.84	1.88

Total 50 cases were studied out of which males were 23 in number and females were 27 in number. The cases were divided on the basis of age i.e. younger ones (n=33) in age group <45 years and elder ones (n=17) in the age group of 45 years or more. Depending upon the degree of tissue handling or tissue injury, these cases were divided in two groups-major (34) tissue injury and minor (16) tissue injury.

DISCUSSION

Preoperative level of serum electrolyte (on day-1)

In the present study, the average preoperative level of serum sodium 140.3 meq/L (131-148 meq/L), serum potassium - 4.02 meq/L (3.4 - 5.1 meq/L), serum chloride 100.12 meq/L (86-106 meq/L) serum Calcium 1.30 meq/L (1.40-1.12 meq/L) and serum Magnesium 2.0 meq/L (2.4-1.6 meq/L) was observed. Preoperative values, which serve as control, show that all patients have normal serum electrolytes. These observations are in accordance to that of study of Rassam and Lobo.[9,10]

Changes of serum sodium, potassium and serum chloride calcium and magnesium levels in the postoperative period (day 0 to day 7)

In the present series of observation, there was fall in the serum sodium level in the day of operation (Day 0) in all cases, which was continued in the 1st postoperative day (Day+1). From 2nd postoperative day (+2 day) onwards the serum Sodium level started to rise gradually and attained its normal preoperative value on 4th postoperative day (+4) onwards in most cases. The preoperative day level was restored in all cases by the 7th postoperative day (+7 day). Similar changes occur in the levels of serum chloride as that of serum Sodium. There was elevation of serum potassium on the day of operation (day 0), which was of its highest on +1 day. Then there was a gradual fall in its level to attain the preoperative value by round 4th postoperative day (day +4). By the 7th postoperative day (+7) it has attained preoperative value in all the cases. So, the response of serum potassium was contrary to that of serum sodium and serum chloride. These responses of serum electrolytes to tissue injury in the present study are similar to the observations made by Johnson and Steele and Andrew.[11,12] The hormonal response to surgery i.e. catecholamine release and stimulation of hypothalamo pituitary adrenal axis by stress hormones cause an increase in cortisol, aldosterone and ADH release. So, the result is marked oliguria for 24-48 hours. During this period, there is retention of Sodium and Chloride and increased urinary excretion of Potassium which may last for 48-72 hours. This whole mechanism can be explained as production of extensive inflammatory exudates around traumatized tissue. This exudate is rich in water, sodium, chloride and protein all of which necessary for healing process. Therefore water, sodium and chloride retention occur. Breakdown of protoplasm of injured tissue (especially skeletal muscle) lead to Potassium release, which is excreted in urine.[13,14] During early postoperative period, there may be slight rise of serum potassium, as it is being produced in such a great quantity that it may not be excreted by kidney with sufficient speed. This explains Potassium paradox i.e. increased plasma level despite negative metabolic balance. Also, plasma level of sodium and chloride are low despite their retention. This sodium paradox attributed to water retention caused by increased ADH secretion.[15]

Effect of degree of tissue trauma on serum electrolytes

It is very evident from table - 3 that fall of serum Sodium and serum chloride in day 0 and day +1 was more in major degree of tissue trauma than in cases with minor degree of tissue trauma. The rise of serum potassium on day 0 and on day +1 was much more in comparison to cases of minor tissue handling. This clearly showed that the degree of metabolic response in surgical trauma expressed in form of changes in electrolytes is directly proportional to the degree of tissue trauma. A fact established by various observers like Desborough.[16]

Effect of age on serum electrolyte

It was found that sodium and chloride retention, water retention and potassium excretion in urine are more marked in elder age group as well as the changes take more time to return to preoperative levels. Similar observations were made by Sharkawy et al and Allison et al These changes are due to age related alterations in homeostatic mechanism.[17,18]

Effect of sex on serum electrolyte

In this study, there was no sex related difference observed after surgical trauma.

CONCLUSION

There was tendency of the body to conserve Sodium, Chloride on the day of operation and on 1st postoperative day, while Potassium is excreted from body in these days. From postoperative day onwards the trend started to attain preoperative values and completed by day 4 postoperatively. The changes in serum electrolytes were directly proportional to degree of tissue trauma or tissue handling. The changes in serum electrolytes are more in magnitude in elderly cases than in comparison to younger ones. It takes comparatively more time to return to preoperative value in elder age group (7 postoperative days) in comparison to younger age group (4 postoperative days).

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