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# A Study On Serum Electrolyte Changes In Explorative Laprotomy Cases

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***Abstract:*** *Any type of surgical trauma whether elective or emergency causes various effects on the human body including a great impact on the physiology of fluid and electrolytes within the body. Mortality and morbidity is very common due to the fluid imbalance after major surgical trauma. Objectives of the study are to study serum electrolyte changes in post operative cases (patients undergoing Explorative Laparotomy) and to study which serum electrolyte is markedly changed in post operative patients. The study was conducted in department of physiology, BRIMS, Bidar, during the period from January 2014-June 2015. The study included 50 subjects from both genders (27 males and 23 females), adult age group except paediatric age group getting admitted for explorative laparotomy, explaining about the nature and purpose of study, the subjects were included after obtaining their consent. Detailed history was recorded. Blood sample was taken and sent for electrolyte analysis on pre-operative day (-1), on the day of operation (0), next four consecutive days (1,2,3,4) and seventh post-operative day(7) using Flame photometer. Statistical analysis was done using student's t test. Statistically significant results are obtained on comparing pre-operative day(-1) with day of operation (0), next four consecutive days (1,2,3,4) and seventh post-operative day(7) among 50 study subjects in all three electrolytes. The study shows significant changes in serum electrolyte in post-operative period .*

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## I. Introduction:

The charged substances that result when a salt is dissolved in solution are called 'electrolytes'[1]. There are many electrolytes in serum. These serum electrolytes are involved in various activities essential for life, including nerve transmission, energy production, PH balance, muscle contractions, fluid balance and many other.

Sodium, potassium and chloride are widely distributed ions in body fluids. They are major electrolytes, where their concentrations are closely regulated ,important in acid base balance, electrolyte balance, substrate transport and osmotic balance[2].Osmolar concentrations in between extracellular and intracellular compartments are regulated by movement of the solutes and/or body water. Changes in solute concentrations such as $Na^+$ and glucose, that do not move freely across membranes, will cause water to move intraspacially from intracellular to extracellular in order to equilibrate the solute concentrations. Osmolality ,thus, depends on the solute concentrations.

Emergency and elective surgery, trauma, sepsis, feeding, fasting, and an aesthesia all affect the electrolyte balance[3].Stress response to surgery is characterized by increase in the secretion of pituitary hormones and the activation of sympathetic nervous system[4].

In order to maintain isotonicity, circulating intravascular volume, and adequate oxygen-carrying capacity, Postoperative fluid balance is important. Fluid balance involves giving fluids appropriately based on the individual patient's needs and giving enough fluids. Total fluid loss in the average adult is about 2500 mL/day. This includes 100–200 mL/day through the gastrointestinal tract, insensible fluid losses (through the lungs and skin) of about500–1000 mL/day, and urine output of about 1000 mL/day. The fluid volume required, therefore, is generally about 2500 mL/day for a 70-kg adult, with Na+ of 30 mEq/L and $K^+$ of 15–20 mEq/L[5].

The fluids available are colloids, crystalloids, blood and blood products. In general, crystalloids containing electrolytes found in plasma are administered. Blood and/or blood products might be required depending on the degree of blood loss[5].

Fluid and electrolyte imbalances may occur rapidly in the surgical patient, and can be caused by numerous factors, including preoperative fluid and food restrictions, intra-operative fluid loss, or the stress of surgery[6].

Any type of surgical trauma, whether elective or emergency, causes various effects on the human body including a great impact on the physiology of fluid and electrolytes within the body[7].

Principal systemic responses to surgery can be given as Sympathetic nervous system activation, Endocrine responses which include the pituitary hormone secretion and insulin resistance, and Immunological and hematological changes like cytokine production, acute phase reaction, neutrophil leucocytosis and lymphocyte proliferation[4].

After surgical trauma, there is cortisol release from adrenal cortex stimulated by ACTH as well as ADH release from posterior pituitary through direct stimuli from injured area. A variety of stimuli in addition to osmotic pressure changes and ECF volume aberrations increase vasopressin(ADH) secretion these include surgical stress, pain, nausea and some emotions[7].

So, this study has been designed to know the pattern of changes in the levels of Serum electrolytes in the patients who have undergone exploratory laparotomy.

## II. Materials and methods:

The study titled 'A **Study on Serum electrolyte changes in the post-operativecases**' was carried out in the physiology department, BRIMS, Bidar, Karnataka, India.

**Materials required for the study**

- Flame photometer (Model No. ELICO CL-361, Type – 189, 1483/2008) was used for the clinically important measurements of the concentrations of Potassium, Sodium and Chloride ions in the serum samples of the individuals including dilution ratios, interferences and calibration curve
- About 2 cc of blood sample from each individual was collected for the electrolyte analysis.
- Volumetric Glassware and Pipettes for Flame photometry studies.

**Duration of the study:**

The entire study was carried out for over a period of 18 months i.e. from January 2014 to June 2015.

**Data Source:**

50 patients who are undergoing explorative laparotomy admitted in surgical wards of BRIMS, Bidar, Karnataka, India are selected as subjects for the study of serum electrolytes. And to study the electrolyte changes occurring in serum after explorative laparotomy, the cases were selected among the indoor patients BRIMS, Bidar, Karnataka. Following a description of the nature and purpose of study, those subjects who are willing to participate in the study are included.

A pre-tested structuredproforma was used to record relevant information from each individual. A detailed history was taken from the subjects followed by detailed general physical and systemic examination..

The information and particulars of Anaesthesia given during the operation type and quality of the IV fluid infused was recorded.

**Period of investigation:**

About 2 cc of blood sample from each individual was collected and sent for the electrolyte analysis on,

1. One day before the operation (-1)
2. On the day of operation (0), after surgery
3. Next four consecutive post operating days (1, 2, 3, 4)
4. On the 7th post operative day (7)

The subjects were screened using certain inclusion and exclusion criteria to be considered for the study.

**Inclusion criteria:**

1. Patients of both sexes except pediatric age group.
2. Undergoing an explorative laprotomy.

**Exclusion criteria:**

1. Patients having any other pathology except for which they are operated.

**Statistical analysis:**

- Descriptive and inferential statistical analysis has been carried out in the present study.
- Student t-test (paired and unpaired) is used
- $P<0.05$ will be taken as statistically significant

**Statistical software:**

SPSS (V.19, IBM, USA) is used for the analysis and Microsoft Word and Excel have been used to generate graphs, tables etc

## III. Results

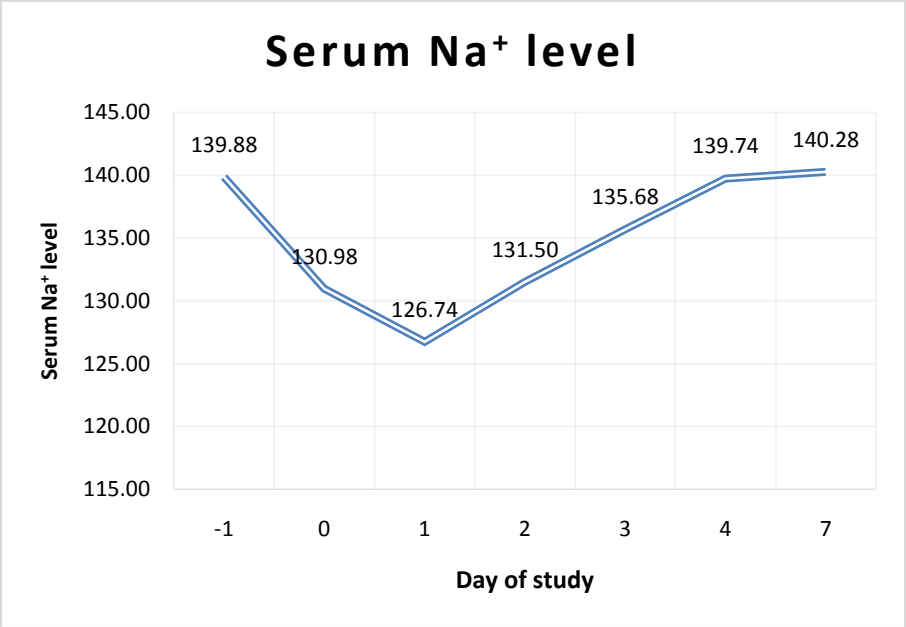
In the present study,50 subjects of both the age groups (male and female excluding the pediatric age group) undergoing explorative laparotomy were taken into consideration and the following results were evaluated.

In the present study on the basis of age groups considered for both male and female subjects, theaverage distribution of females (48.39yrs) is more in number when compared to that of male subjects (46.63yrs). And

on the basis of gender, the number of male subjects (54%) were found more in number when compared to that of female subjects(46%).

| Time point | Minimum (mEq/L) | Maximum (mEq/L) | Mean (mEq/L) | Std. Deviation |
|---|---|---|---|---|
| **-1** | 131.00 | 148.00 | 139.88 | 4.25 |
| **0** | 120.00 | 142.00 | 130.98 | 4.95 |
| **1** | 116.00 | 142.00 | 126.74 | 5.21 |
| **2** | 125.00 | 144.00 | 131.50 | 4.45 |
| **3** | 130.00 | 147.00 | 135.68 | 4.02 |
| **4** | 130.00 | 148.00 | 139.74 | 4.32 |
| **7** | 131.00 | 147.00 | 140.28 | 4.16 |

**Table 1**:Evaluation of Mean Serum $Na^+$ levels among the study subjects.

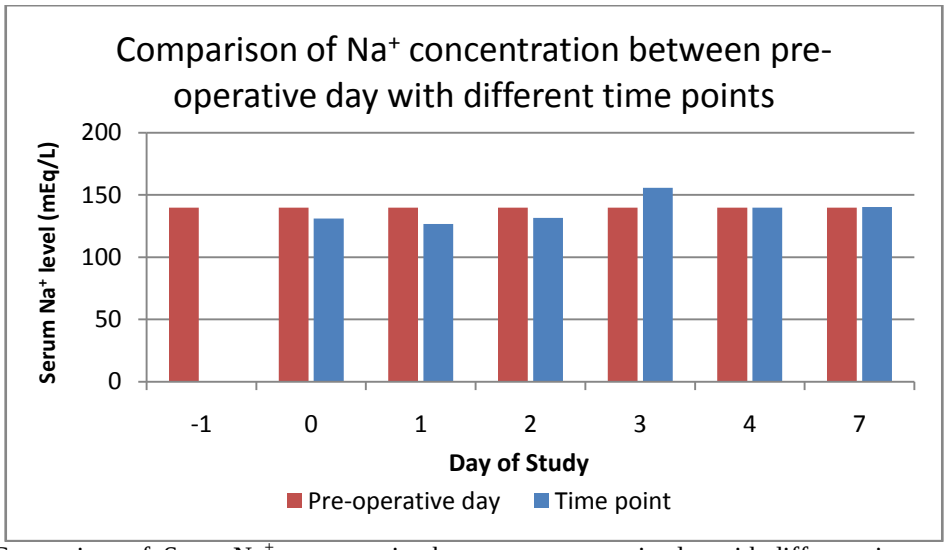



**Graph1**: Mean Serum $Na^+$ levels among the study subjects.

From the table1 and graph1 it can be noted that the mean serum $Na^+$ level falls on Day 0 i.e. the day of operation. Maximum fall was observed on Day 1 and then returns to normal on Day 4 as it reaches the pre-operative value by Day 7.

| Time points of Comparison | | Mean(mEq/L) | N | Std. Deviation | Mean difference | P-value |
|---|---|---|---|---|---|---|
| **Pair 1** | -1 | 139.88 | 50 | 4.246 | 8.900 | .000 |
| | 0 | 130.98 | 50 | 4.951 | | |
| **Pair 2** | -1 | 139.88 | 50 | 4.246 | 13.140 | .000 |
| | 1 | 126.74 | 50 | 5.209 | | |
| **Pair 3** | -1 | 139.88 | 50 | 4.246 | 8.380 | .000 |
| | 2 | 131.50 | 50 | 4.450 | | |
| **Pair 4** | -1 | 139.88 | 50 | 4.246 | -15.800 | .434 |
| | 3 | 155.68 | 50 | 141.813 | | |
| **Pair 5** | -1 | 139.88 | 50 | 4.246 | .140 | .469 |
| | 4 | 139.74 | 50 | 4.318 | | |
| **Pair 6** | -1 | 139.88 | 50 | 4.246 | -.400 | .002 |
| | 7 | 140.28 | 50 | 4.160 | | |

**Table 2**: Comparison of Serum $Na^+$ concentration between pre-operativeday with different time points among the 50 study subjects

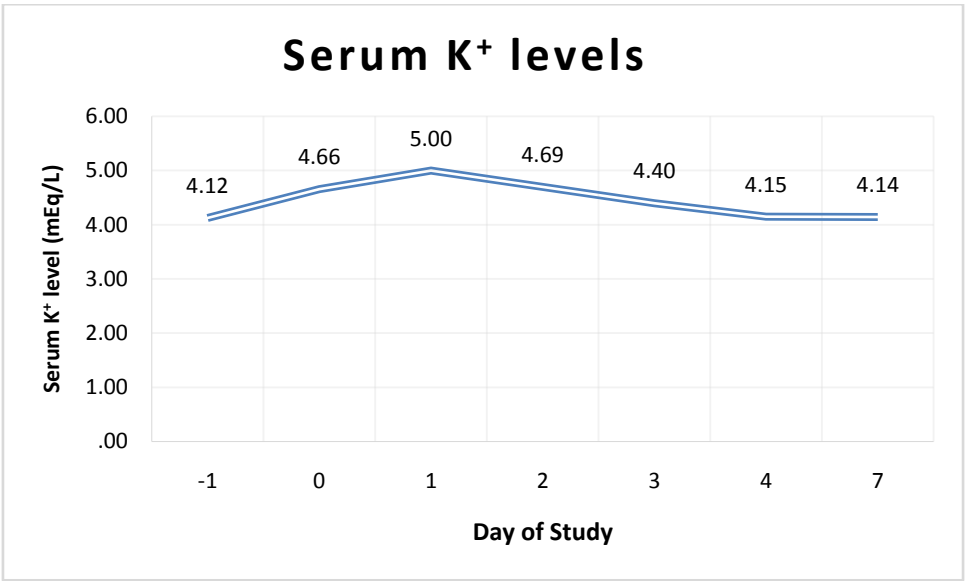



**Graph 2**: Comparison of SerumNa$^+$ concentration between pre-operativeday with different time points among the 50 study subjects

From table2 and graph2 statistical significant results are obtained on comparing pre-operative day with 0, 1, 2, 7 Days.

| Time point | Minimum(mEq/L) | Maximum(mEq/L) | Mean(mEq/L) | Std. Deviation |
|---|---|---|---|---|
| **-1** | 3.50 | 5.10 | 4.12 | .43 |
| **0** | 4.00 | 5.70 | 4.66 | .49 |
| **1** | 4.20 | 6.20 | 5.00 | .49 |
| **2** | 4.10 | 5.80 | 4.69 | .48 |
| **3** | 3.60 | 5.50 | 4.40 | .50 |
| **4** | 3.40 | 5.20 | 4.15 | .46 |
| **7** | 3.50 | 5.10 | 4.14 | .44 |

**Table 3**:Evaluation of Mean Serum K$^+$ levels among the study subjects.

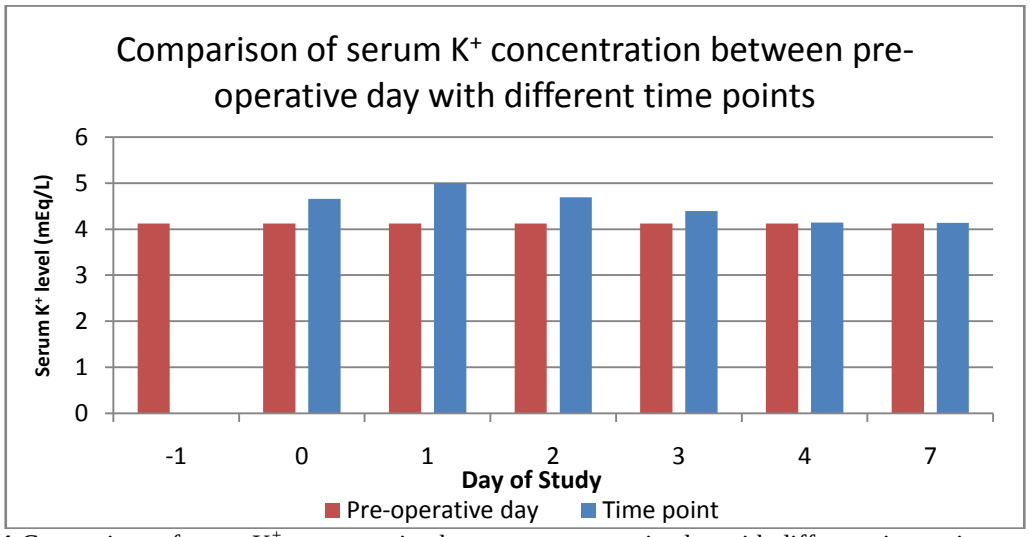



**Graph 3:**Mean Serum K$^+$ levels among the study subjects

From the table3 and graph3 it can be observed that the Serum K+ level rise on Day 0, Day 1. Maximum rise was seen on Day 1, and then decreased gradually. By Day 4 it reached the pre-operative level and finally by Day 7, it returned to normal level in all cases.

| Time points of comparison | | Mean(mEq/L) | N | Std. Deviation | Mean difference | P-value |
|---|---|---|---|---|---|---|
| **Pair 1** | **-1** | 4.12 | 50 | 0.43 | -0.53 | 0.00 |
| | **0** | 4.66 | 50 | 0.49 | | |
| **Pair 2** | **-1** | 4.12 | 50 | 0.43 | -0.87 | 0.00 |
| | **1** | 5.00 | 50 | 0.49 | | |
| **Pair 3** | **-1** | 4.12 | 50 | 0.43 | -0.57 | 0.00 |
| | **2** | 4.69 | 50 | 0.48 | | |
| **Pair 4** | **-1** | 4.12 | 50 | 0.43 | -0.27 | 0.00 |
| | **3** | 4.40 | 50 | 0.50 | | |
| **Pair 5** | **-1** | 4.12 | 50 | 0.43 | -0.02 | 0.29 |
| | **4** | 4.15 | 50 | 0.46 | | |
| **Pair 6** | **-1** | 4.12 | 50 | 0.43 | -0.02 | 0.25 |
| | **7** | 4.14 | 50 | 0.44 | | |

**Table4:**Comparison of $K^+$ concentration between pre-operativeday with different time points among the 50 study subjects.

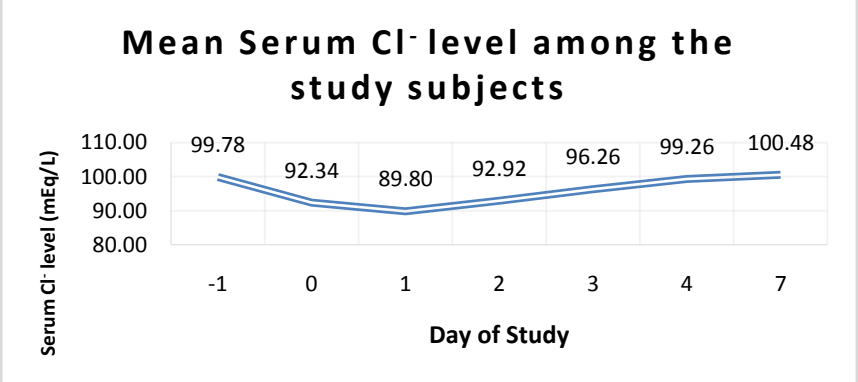



**Graph 4:**Comparison of serum$K^+$ concentration between pre-operativeday with different time points among the 50 study subjects

From table4 and graph4 statistical significant results are obtained on comparing pre-operative day with 0, 1, 2, 3 Days.

| Time point | Minimum (mEq/L) | Maximum (mEq/L) | Mean (mEq/L) | Std. Deviation |
|---|---|---|---|---|
| **-1** | 86.00 | 106.00 | 99.78 | 3.77 |
| **0** | 79.00 | 98.00 | 92.34 | 4.19 |
| **1** | 75.00 | 97.00 | 89.80 | 4.44 |
| **2** | 80.00 | 98.00 | 92.92 | 3.95 |
| **3** | 83.00 | 100.00 | 96.26 | 3.43 |
| **4** | 85.00 | 104.00 | 99.26 | 3.38 |
| **7** | 87.00 | 105.00 | 100.48 | 3.47 |

**Table 5**: Evaluation of Mean Serum $Cl^-$ levels among the study subjects.

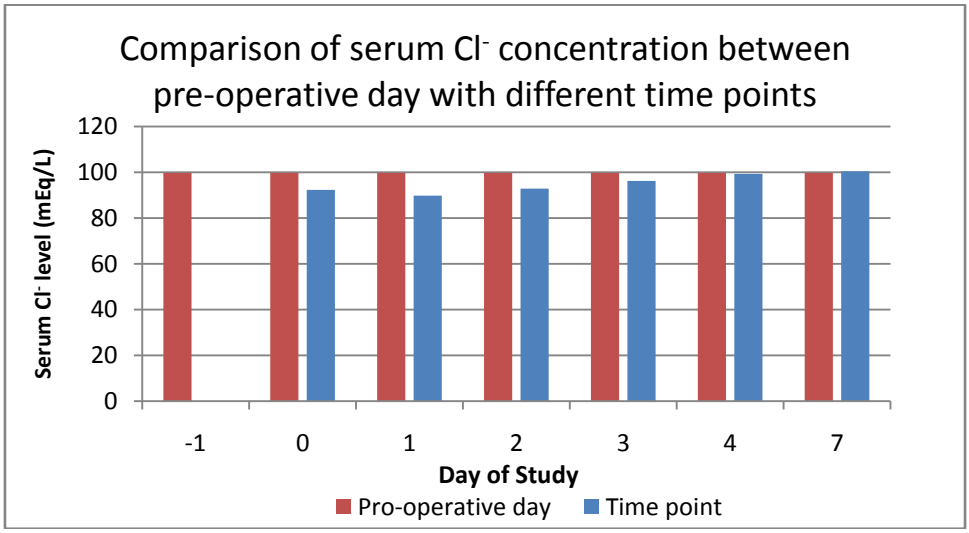



**Graph 5**: Mean Serum $Cl^-$levels among the study subjects

From table5 and graph5 it is clear that the serum $Cl^-$ falls gradually. Maximum fall is on Day 1,then it rises, normalizes by Day 4, and returns to the pre-operative value by Day 7 in all cases.

| Time points of comparison | | Mean (mEq/L) | Std. Deviation | Std. Error Mean | Mean difference | P-value |
|---|---|---|---|---|---|---|
| **Pair 1** | **-1** | 99.78 | 3.770 | .533 | 7.440 | .000 |
| | **0** | 92.34 | 4.187 | .592 | | |
| **Pair 2** | **-1** | 99.78 | 3.770 | .533 | 9.980 | .000 |
| | **1** | 89.80 | 4.440 | .628 | | |
| **Pair 3** | **-1** | 99.78 | 3.770 | .533 | 6.860 | .000 |
| | **2** | 92.92 | 3.953 | .559 | | |
| **Pair 4** | **-1** | 99.78 | 3.770 | .533 | 3.520 | .000 |
| | **3** | 96.26 | 3.427 | .485 | | |
| **Pair 5** | **-1** | 99.78 | 3.770 | .533 | .520 | .030 |
| | **4** | 99.26 | 3.379 | .478 | | |
| **Pair 6** | **-1** | 99.78 | 3.770 | .533 | -.700 | .000 |
| | **7** | 100.48 | 3.471 | .491 | | |

**Table 6:**Comparison of serum $Cl^-$ concentration between pre-operativeday with different time points among the 50 study subjects.




**Graph6**: Comparison of $Cl^-$ concentration between pre-operativeday with different time points among the 50 study subjects

From table6 and graph6 statistically significant results are obtained on comparing prior day with Day 0, Day 1, Day 2, Day 3, Day 4 and Day 7.

## IV. Discussion

**Evaluation of Pre-operative levels of serum electrolytes (Day -1)**

In the present study, the pre-operative serum sodium level varied within a range of 131 mEq/L to 148 mEq/L with an average of 139.88mEq/L, and that of serum potassium varies from 3.50mEq/L to 5.1 mEq/L with an average of 4.12mEq/L. The pre-operative serum chloride varied from 86 mEq/L to 106 mEq/L with an average of 99.78 mEq/L.

**Evaluation of changes in serum sodium, potassium and serum chloride levels in the post operative period**

In the present series of observation, there was a fall in the serum sodium level on the day of operation (Day 0) in all cases, which was continued in the first post operative day (Day 1). From the second post operative day (Day 2) onwards, the serum sodium level started to rise gradually and attained its normal pre-operative value on the fourth post-operative day (Day 4) in most cases. The pre-operative day level was restored in all cases by the seventh post-operative day (Day 7).

In the present series of observation, there was an elevation in the serum potassium level on both the day of operation (Day 0) and the first post operative day (Day 1). The serum potassium level rose to a maximum level on thefirst post operative day (Day 1) and then it gradually decreased. By the fourth post operative day (Day 4), the serum potassium level reached the pre-operative level. Finally, on the seventh post operative day (Day 7), it completely returned to the normal level in all the cases.

In the case of serum chloride , it was clear that the level fell gradually through the day of operation (Day 0) and the maximum fall of serum chloride levels was observed on the first post operative day (Day 1). Then the levels were observed to be raised and normalized by the fourth post-operative day (Day 4).The levels of serum chloride returns to the pre-operative value by the seventh post-operative day (Day 7) in all the cases. Similar changes were observed in the levels of serum sodium and serum chloride.

So, the response of serum potassium was contrary to that of serum sodium and serum chloride.

These responses of serum electrolytes to the stress of exploratory laparotomy in the present study are similar to the observations made by Desborough (1993)[4], Fryan (1986)[8], Dileep and David (2006)[3], Das (2008)[9], Irving (1953)[10].

The normal metabolic response to surgery and trauma which was observed in this study consists of multiple hormonal action. These changes mainly involve Arginine vasopressin (AVP), Follicle-Stimulating hormone (FSH), Adrenocorticotrophic hormone (ACTH), Luteinizing hormone (LH), Thyroid stimulating hormone (TSH). Also, Cortisol secretion from the adrenal cortex, as a result of stimulation by ACTH, increases rapidly after the start of surgery. Researchers also discussed of transient increase in the concentrations of plasma glucagon after major surgery Desborough (1993)[4], Lyons FM and Meeran K (1997)[11], Nicholson G, Hall GM and Burrin JM (1998)[12].

There is a decrease in membrane potential of injured cells and this caused entry of sodium into cell and exit of intracellular potassium (Cunning et al, 1982[13]). The initial fall in the serum sodium after surgical trauma inspite of conservation is due to this transfer of sodium in to cell and raise of serum potassium is indicative of mobilization of intracellular potassium.

**Comparison of Serum electrolyte concentration between pre-operative day with different time points among the 50 study subjects**

By the comparison of serum sodium concentration between pre-operative and different time points among the study subjects , statistically significant results are obtained on comparing pre-operative day with the day of operation (Day 0),First post-operative day (Day 1), Second post-operative day (Day 2), seventh post-operative day (Day 7).

In case of serum potassium levels, statistical significant results are obtained on comparing pre-operative day with the day of operation (Day 0), First post-operative day (Day 1),Second post-operative day (Day 2), third post-operative day (Day 3).

The same when compared in the case of serum chloride, statistically significant results are obtained on comparing prior day with the day of operation (Day 0) , First post-operative day (Day 1),second post-operative day (Day 2), third post-operative day (Day 3),fourth post-operative day (Day 4) and seventh post-operative day (Day 7).

There was no significant difference observed in the serum electrolyte levels by Maria valadao et al (2015)[14], and Keshab et al (2014)[15], where as the studies of Shenqi et al (2013)[16], and Kumkum et al (2010)[17], Krishnamoorthy&Shobha (2002)[18] reported a decrement in the serum sodium levels and increase in the serum potassium levels post operatively.

Emergency and elective surgery, sepsis, trauma, fasting, feeding and anaesthesia all affect the electrolyte balance [6].

Any type of surgical trauma, whether elective or emergency, causes various effects on the human body including a great impact on the physiology of fluid and electrolytes within the body. After surgical trauma, there is cortisol release from adrenal cortex stimulated by ACTH as well as ADH release from posterior pituitary through direct stimuli from injured area. A variety of stimuli in addition to osmotic pressure changes and ECF volume aberrations increase vasopressin(ADH) secretion these include surgical stress, pain, nausea and some emotions [19].

## V. Conclusion

The following conclusions can be drawn from results of the study

- The pre-operative values, which serve as control in the present study are identical with those of established literature.
- Statistical significant results are obtained on comparing pre-operative day with different time points in all three electrolytes.

Though our study is by no means exhaustive, it does provide a glimpse into serum electrolyte changes in patients undergoing explorative laparotomy. Although we understand these changes to some extent and since few studies have been done on this aspect, further research is needed to study the urine output and level of urinary electrolytes post-operatively.

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