



ORIGINAL RESEARCH PAPER

ANESTHESIOLOGY

EVALUATION OF METABOLIC PROFILE AND ELECTROLYTE VARIATION USING 0.9% NORMAL SALINE AND RINGER'S LACTATE FOR FLUID REPLACEMENT IN MAJOR ABDOMINAL SURGERIES

KEY WORDS: 0.9% Normal saline, Ringer's lactate, perioperative fluids, serum electrolytes.

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ABSTRACT

INTRODUCTION: Perioperative fluid replacement therapy is an universal practice but if done inappropriately may lead to poor postoperative outcome. As 0.9%Normal Saline (NS) and Ringer's Lactate(RL) both are used frequently but there is lack of consensus regarding the ideal fluid. Our trial compared both the fluids regarding perioperative metabolic and biochemical status along with 24hours urine output. **MATERIAL AND METHODS:** Prospective randomized trial was done in 120 ASA I&II patients undergoing major abdominal surgery receiving either NS or RL intra-operatively 15ml/kg/hr. ABG analysis done preoperatively, immediate-postoperatively and 24hours post-surgery. Results were analyzed with statistical tests. **RESULTS:** : NS Group had lower mean pH(7.36±0.03), HCO3-(21.98±1.31), BE(-2.77±1.88) with higher levels of Sodium(139.68±3.27) and Chloride(108.48±3.86) mmol/l when compared with RL Group (7.41±0.03, 24.89±1.31, 0.42±1.52, 137.22±2.31 and 102.95±3.33) in the immediate postoperative period. But no significant difference noted after 24 hours. **DISCUSSION:** Body's homeostasis deals with large water and solute fluxes without remarkable change in blood chemistry in health but anesthetic agents blunts the normal physiological response to volume depletion, surgical stress etc. Effect of different fluids on these responses are largely unknown. **CONCLUSION:** Ringer's lactate maintains a more physiological picture of acid-base balance in the intraoperative period but both NS & RL can be safely considered for intraoperative usage in healthy patients

INTRODUCTION:

Intravenous Fluid therapy has gained therapeutic importance in 1880s for treatment of cholera patients.¹ Intravenous Fluid administration gained much development in the late 1950s and early 1960.² In patients undergoing major abdominal surgery, volume replacement plays a very important role as intravascular volume depletion occurs as a result of perioperative fasting, surgical blood loss, evaporation, urinary excretion, vasodilatation caused by anaesthesia. Too much of fluid restriction can lead to hypovolemia and hypoperfusion leading to microcirculatory disturbances which might result in tissue damage and organ dysfunction. Whereas, too liberal fluid may also lead to cardiac dysrhythmias, pulmonary edema, excessive diuresis, and gastrointestinal complications. Major surgeries may also cause pre-renal oliguric state due to blood loss, fluid shift, occult fluid loss and stress response. So, the concept of perioperative fluid therapy has evolved over the years with an aim to maintain normovolemia and homeostasis.

Crystalloid fluids are preferred but there is still lack of consensus regarding the ideal perioperative fluid. 0.9% Normal saline contains 154 mEq/l of sodium and 154 mEq/l of chloride (supraphysiological i.e almost 50% higher than in plasma so according to the Stewart's hypothesis excessive administration can cause hypernatremia, hyperchloremia, and acidosis) have adverse effects on clinical outcomes in postoperative and critically ill patients. The Strong ion difference (SID) of 0.9% Normal Saline is 0 (SID of ECF is around +40).^{3,4}

Ringer's lactate is a balanced salt solution containing Na⁺ -130; K⁺ - 4; Ca²⁺ -3; Cl⁻ -109; Lactate -28⁵ and osmolarity 274mOsmol/L.

We undertook the present study to evaluate the metabolic profile and electrolyte variations of both 0.9% Normal Saline

and Ringer's Lactate infused at 15ml/kg/hr in patients undergoing major abdominal surgeries in the immediate postoperative period and their consequences postoperatively 24 hours later as primary outcome and urine output in 24 hours as secondary outcome.

MATERIAL AND METHODS : After the approval from the Institutional Ethics Committee (Human) and written informed consent from each patient a prospective, comparative randomised trial was carried out (Considering 95% Confidence interval with 80% power, marginal error of ± 10 and taking the findings of the study by Veena Chatrath et al⁶) in ASA grades I and II of either sex, between 20-60 years of age and allocated into two groups of 60 each, either receiving intravenous 0.9% Normal Saline (Group NS) or Ringers lactate (Group RL) at 15ml/kg/hr in patients undergoing abdominal surgeries (open chole with appendicectomy, Nephrolithotomy, Hemicolectomy, Pyeloplasty, CBD exploration, Cholecystectomy with choledocholithotomy and pseudocyst of pancreas) of 60-120 minutes duration.

Patients with ASA grade III and above, having severe renal impairment, cardiac disease, hepatic impairment, pulmonary disease, diabetes mellitus, coagulopathy, with impaired acid base status and electrolytes were excluded from the study.

After proper positioning on the OT table, the preoperative baseline vitals (heart rate, SpO₂, ECG, temperature, non-invasive systolic and diastolic blood pressure) of the patients were recorded. Patients were catheterised with Foleys catheter (if not done earlier). Arterial specimen obtained by arterial puncture from radial artery after taking all required aseptic and antiseptic measures in a heparinized air tight syringe with prior 'Allen test'. The blood sample was analysed for Arterial pH and serum electrolytes using EC8-ABG Cartridge. After first arterial sample, the test fluid was started in the intravenous line, according to randomize allocation, at

the rate of 15mg/kg/hr till the end of the surgical procedure.

The patients in all the groups received Inj Glycopyrrolate 6 mcg/kg IV, inj Pantoprazole 40mg, inj Ondansetron 0.1 mg/kg BW IV over 10 seconds as premedication before induction and Inj Fentanyl citrate 2 mcg/kg body weight IV, Inj Diclofenac 75 mg IV for maintenance of analgesia in the intraoperative period. Induction done with Inj. Propofol 2 mg/kg BW IV after preoxygenation for 3 minutes. To facilitate endotracheal intubation Inj. Atracurium besylate 0.5 mg/kg BW IV given. Airway was secured using an appropriate sized cuffed endotracheal tube and confirmed by auscultation, bilateral equal chest rise and capnogram. Maintenance done using oxygen, nitrous oxide and sevoflurane. Intra-operative hemodynamic changes were continuously monitored. Blood transfusion was given to patient when blood loss exceeded >20% of the estimated blood volume.⁷ At the end of surgery, arterial blood gas analysis and electrolytes (serum sodium, potassium, and chloride) were done. Patients were reversed with inj neostigmine sulphate and glycopyrrolate. Extubation was done after evaluating adequate reversal criteria and oxygenation done via breathing circuit for 5 minutes.

In the postoperative period mixture of 0.9% Normal Saline, Ringer's lactate and DNS mixture administered at the rate of 1.5ml/kg/hr intravenously. 24 hours post operation again arterial sample was taken for analysis. Total urine output at the end of 24 hours was measured.

STATISTICAL ANALYSIS- Demographic data and arterial blood gas analysis data were tabulated (predesigned and pretested proforma) as Mean±SD. The statistical analysis was performed using the computer program, Statistical Package for Social Sciences (SPSS for Windows, version 20.0. Chicago) and Microsoft Excel 2010. Results of continuous measurements are presented as Mean±SD and compared using student-t test. Discrete data are expressed as number (%) and are analysed using Chi-square test and Fischer's exact test (where the cell counts were <5 or 0). Pearson's correlation coefficient(r) was used to measure the associations among continuous variables. Statistical significance was fixed at 5% level (p-value <0.05). Some results on continuous measurements are also presented as Mean±SD are compared using Analysis of Variance (ANOVA). Where the p-value was found significant (p<0.05) among 3 groups, post hoc analysis was done to find out the significance between 2 individual groups.

RESULTS- Both the groups were compared using patient's characteristics (age, sex, ASA grading, duration and types of surgery), haemodynamic parameters (mean arterial pressure, pulse rate, SpO₂), temperature and EtCO₂.

The mean value of pH in all three samples (preoperative, immediate preoperative and 24 hours postoperative period) of group NS were 7.40± 0.96, 7.36 ± 0.03, 7.41± 0.02 respectively, whereas in group RL 7.41± 0.03, 7.41± 0.03 and 7.42 ± 0.03 respectively. Thus NS group showed significant fall in pH (p=<0.001) compared to RL but no significant fall within (group NS) the group.

The mean value of Bicarbonate in all three samples of group NS were 24.05±1.73, 21.98±1.31 and 24.63±1.65 respectively, whereas in group RL the values were 24.60±1.93, 24.89±1.31 and 25.03±1.89 respectively. NS group showed significant fall (p=<0.001) in bicarbonate in both between and within the group comparison.

The mean value of Base excess in all three samples of group NS were -0.31± 1.88, -2.77 ± 1.88, and 0.32 ± 1.72 respectively, whereas in group RL the values were 0.22± 2.57, 0.42± 1.52 and 0.81± 2.06 respectively. NS group showed significant fall(p=<0.001) in both between and within the group comparison.

The mean value of Sodium in all three samples of group NS were 137.38±2.70, 139.68± 3.27 and 138.03±3.16 mmol/l respectively, whereas in group RL the values were 137.88 ± 2.74, 137.22±2.31 and 137.95±1.72 mmol/l respectively. Thus NS showed significant rise in Sodium (p=<0.001) between but not within the group comparison.

Chloride in all three samples of group NS were 104.32± 3.12, 108.48 ± 3.86 and 104.35 ± 4.12 mmol/l respectively, whereas in group RL the values were 103.50± 3.48, 102.95 ± 3.33 and 103.75 ± 3.27 mmol/l respectively. NS group showed significant rise in Chloride values (p= <0.001) in both between and within the group.

No significant variation of metabolic and electrolyte values in group RL when comparison done within the group.

Variations in the mean values of Anion gap, PaCO₂, K⁺ in all three samples showed no significant change in both the groups in both between and within the group comparison.

Mean 24 hr urine output in group NS was 2396.83 ± 631.69 ml and 2202.50 ± 645.94 ml in group RL (p=0.0983432).

Though the NS group values showed statistically significant differences but values were within normal physiological range. So none of the patients required treatment for acidosis or hyperchloremia or hypernatremia.

Bar diagrams of the above findings are shown below

COMPARISON OF METABOLIC AND ELECTROLYTE PARAMETERS PREOPERATIVELY

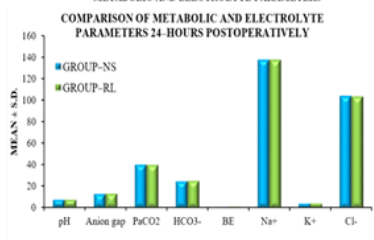
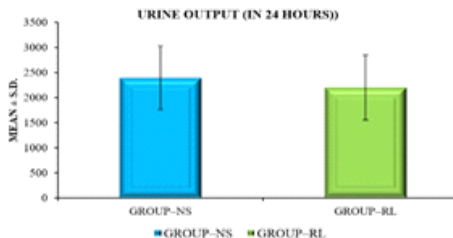
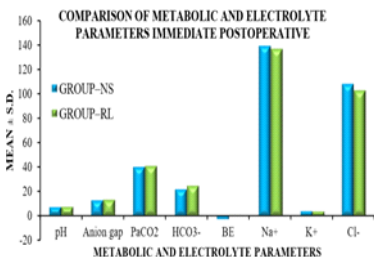
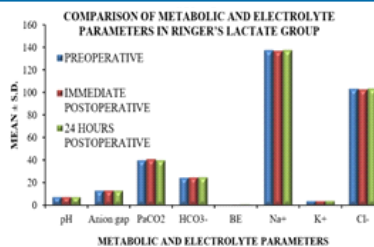
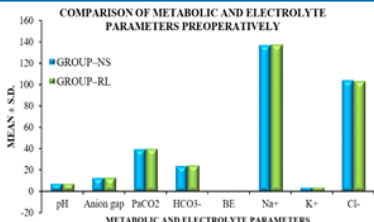
METABOLIC AND ELECTROLYTE PARAMETERS	GROUP-NS		GROUP-RL		p-value
	Mean	± S.D.	Mean	± S.D.	
pH	7.4	0.96	7.41	0.03	0.22879
Anion gap	12.85	1.94	13.07	1.84	0.53122
PaCO ₂	39.85	2.10	40.11	2.55	0.53937
HCO ₃ ⁻	24.05	1.73	24.60	1.93	0.10198
BE	-0.31	1.88	0.22	2.57	0.20295
Na ⁺	137.38	2.70	137.88	2.74	0.31589
K ⁺	3.75	0.31	3.85	0.32	0.10798
Cl ⁻	104.32	3.12	103.50	3.48	0.17835

COMPARISON METABOLIC AND ELECTROLYTE PARAMETERS IMMEDIATE POSTOPERATIVE PERIOD

METABOLIC AND ELECTROLYTE PARAMETERS	GROUP-NS		GROUP-RL		p value
	Mean	± S.D.	Mean	± S.D.	
pH	7.36	0.03	7.41	0.03	<0.001
Anion gap	12.92	2.24	13.23	2.20	0.43611
PaCO ₂	40.40	1.76	41.00	2.40	0.12374
HCO ₃ ⁻	21.98	1.31	24.89	1.31	<0.001
BE	-2.77	1.88	0.42	1.52	<0.001
Na ⁺	139.68	3.27	137.22	2.31	<0.001
K ⁺	3.85	0.26	3.79	0.31	0.28302
Cl ⁻	108.48	3.86	102.95	3.33	<0.001

COMPARISON OF METABOLIC AND ELECTROLYTE PARAMETERS 24-HOURS POSTOPERATIVELY

METABOLIC AND ELECTROLYTE PARAMETERS	GROUP-NS		GROUP-RL		p-value
	Mean	± S.D.	Mean	± S.D.	
pH	7.41	0.02	7.42	0.03	0.0687
Anion gap	12.83	2.04	13.07	2.22	0.5499
PaCO ₂	40.36	2.04	40.08	1.97	0.4383
HCO ₃ ⁻	24.63	1.65	25.03	1.89	0.2144
BE	0.32	1.72	0.81	2.06	0.1550
Na ⁺	138.03	3.16	137.95	1.72	0.8578
K ⁺	3.74	0.62	3.89	0.29	0.0996
Cl ⁻	104.35	4.12	103.75	3.27	0.3785



COMPARISON OF METABOLIC AND ELECTROLYTE PARAMETERS IN NORMAL SALINE GROUP

METABOLIC AND ELECTROLYTE PARAMETERS	PREOPERATIVE	IMMEDIATE POSTOPERATIVE	24 HOURS POSTOPERATIVE	p-value
	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	
pH	7.40 0.96	7.36 0.03	7.41 0.02	0.8725
Anion gap	12.85 1.94	12.92 2.24	12.83 2.04	0.9694
PaCO ₂	39.85 2.10	40.40 1.76	40.36 2.04	0.2372
HCO ₃ ⁻	24.05 1.73	21.98 1.31	24.63 1.65	<0.001
BE	-0.31 1.88	-2.77 1.88	0.32 1.72	<0.001
Na ⁺	137.38 2.70	139.68 3.27	138.03 3.16	0.0002
K ⁺	3.75 0.31	3.85 0.26	3.74 0.62	0.2991
Cl ⁻	104.32 3.12	108.48 3.86	104.35 4.12	<0.001

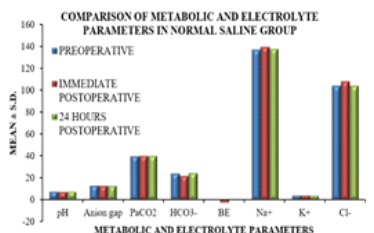
HCO₃⁻
 Group PO vs Group IP: Diff=2.0700, 95%CI=-2.7091 to 1.3091, p=0.0002
 Group PO vs Group 24PO: Diff=6.5000, 95%CI=6.0991 to 1.2910, p=0.0002
 Group IP vs Group 24PO: Diff=2.4300, 95%CI=1.9799 to 3.2901, p=0.0002
 BE
 Group PO vs Group IP: Diff=-2.4600, 95%CI=-3.2089 to -1.6712, p=0.0002
 Group PO vs Group 24PO: Diff=0.0000, 95%CI=-1.1818 to 1.1818, p=0.1043
 Group IP vs Group 24PO: Diff=0.0000, 95%CI=-2.3012 to 2.3012, p=0.0002
 Na⁺
 Group PO vs Group IP: Diff=2.3000, 95%CI=0.9828 to 3.6172, p=0.0002
 Group PO vs Group 24PO: Diff=0.0000, 95%CI=-0.6091 to 0.6091, p=0.4711
 Group IP vs Group 24PO: Diff=-1.6700, 95%CI=-2.9677 to -0.3723, p=0.0097
 K⁺
 Group PO vs Group IP: Diff=0.1000, 95%CI=0.2031 to 5.7669, p=0.0002
 Group PO vs Group 24PO: Diff=0.0000, 95%CI=-1.4700 to 1.4700, p=0.0002
 Group IP vs Group 24PO: Diff=-1.1000, 95%CI=-1.7300 to -0.5200, p=0.0002

COMPARISON OF METABOLIC AND ELECTROLYTE PARAMETERS IN RINGER'S LACTATE GROUP

METABOLIC AND ELECTROLYTE PARAMETERS	PREOPERATIVE		IMMEDIATE POSTOPERATIVE		24 HOURS POSTOPERATIVE		p-value
	Mean	± S.D.	Mean	± S.D.	Mean	± S.D.	
pH	7.41	0.03	7.41	0.03	7.42	0.03	0.1114
Anion gap	13.07	1.84	13.23	2.20	13.07	2.22	0.8899
PaCO ₂	40.11	2.55	41.00	2.40	40.08	1.97	0.0500
HCO ₃ ⁻	24.60	1.93	24.89	1.31	25.03	1.89	0.3846
BE	0.22	2.57	0.42	1.52	0.81	2.06	0.2943
Na ⁺	137.88	2.74	137.22	2.31	137.95	1.72	0.1606
K ⁺	3.85	0.32	3.79	0.31	3.89	0.29	0.2021
Cl ⁻	103.50	3.48	102.95	3.33	103.75	3.27	0.4127

URINE OUTPUT (IN 24 HOURS)

	GROUP-NS		GROUP-RL		p-value
	Mean	± S.D.	Mean	± S.D.	
Urine Output (in 24 hours)	2396.83	631.69	2202.50	645.94	0.0983432



DISCUSSION

We have administered either 0.9% Normal Saline or Ringer's lactate at the rate of 15ml/kg/hr in the intraoperative period followed by combination of 0.9% Normal Saline, Ringer's Lactate and 5% dextrose saline solution at the rate of 1.5ml/kg/hr in the 24-hour postoperative period as maintenance. Similar fluids and doses were used in studies done by Veroli P, Benhamou D(1992),¹⁰ McFarlane C, Lee A(1994)¹¹, Veena Chatrath, Ranjana, Jaspreet Kaur Walia, Anu Sharma, Harjinder Kaur (2016).⁸ Various textbook have also recommended the range of 10-15ml/kg/hr¹² in patients undergoing intraabdominal procedures. Campbell et al.¹³ observed that intraoperative crystalloids given at the rate of 10-15ml/kg/hr during major operations preserve better cardiovascular stability.

Primary outcome of the study was that patients receiving 0.9% Normal saline had lower pH, base excess, and bicarbonates and higher serum chloride and sodium levels in the immediate postoperative period than those receiving Ringer's Lactate. The differences became insignificant over 24 hrs. Secondary outcome i.e 24 hr urine output was comparable in both the groups.

In May 1999 Stefan Scheingraber, MD; Markus Rehm, MD; Christiane Sehmisch; Udilo Finsterer, MD¹⁴ compared the changes in acid-base balance caused by infusion of 0.9% saline and lactated Ringer's solution during anesthesia and surgery among 24 women undergoing major intra-abdominal gynaecologic surgery receiving either fluid in a dosage of 30ml/kg/hr. They found that infusion of 0.9% saline inevitably leads to hyperchloremia and raised Na⁺ level with metabolic acidosis and a concomitant decrease in the strong ion difference and decrease in base excess, which was not observed after administration of lactated Ringer's solution. Also, there were no significant differences between the groups with respect to urine production i.e the results were consistent with our study. In October 2001 Waters, Jonathan H, MD et al¹⁵ compared normal saline and lactated ringer's in abdominal aortic aneurysm repair and found that NS group had significant raised Na⁺ and chloride value while decrease pH and HCO₃⁻. i.e the results were consistent with our study except that the urine output which was significantly higher in normal saline group, may be due to less sample size of our trial. In July 2008 Hadimioglu N, Saadawy I, Saglam T, Ertug Z, Dinckan A¹⁶ did a double-blinded randomized study among 90 patients dividing them into three groups to receive either normal saline, lactated Ringer's or Plasmalyte at 20-30ml/kg/hr and found a significant decrease in pH from the baseline (7.44 to 7.36) and fall in base excess (0.4 to -4.9mmol/l) in the saline group. Similarly, only the saline group had statistically significant elevation in serum chloride (104.2+ 3.2 to 125.4+ 3.7mM/l). The results were consistent to our study in terms of pH, Na⁺ and Cl⁻. In 2012 Manisha P Modi,

Kalpna S Vora, Geeta P Parikh, Veena R Shah¹⁷ did a similar study and found that normal saline group showed significantly increase level of chloride compared to RL group. Also, decrease level of pH and significant fall in base excess. The the results were consistent with our study in terms of pH, Cl and urine output. In December 2016⁶ Veena Chatrath, Ranjana, Jaspreet Kaur Walia, Anu Sharma, Harjinder Kaur compared 0.9% Normal Saline and Plasma-lyte A given at the rate of 15 ml/kg /hr after intraoperative use among 60 patients and found that, patients receiving 0.9% Normal Saline in the immediate postoperative period had higher level of serum sodium levels 139.51mmol/l and chloride 117.31+24.84 mmol/l level compared to Plasma-lyte A{(serum Na+ 134.8mmol/l & serum chloride (96.02+10.16 mmol/l)}. Serum potassium levels remained in physiological range in the two groups also 0.9% Normal Saline group had lower mean pH (7.32+0.05 and) compared to Plasma-lyte A (7.40+0.05) in the immediate postoperative period. There was no significant difference seen amongst the groups after 24 hours. The results of Normal Saline group were similar to our study. In 2019 Bhagat H, Singhal V, Dash HH, Mahajan S, Mishra N and Pandia MP¹⁸ did a prospective evaluation of the effects of normal saline (NS), Ringer's lactate (RL), and a combination of NS and RL on the biochemical, metabolic, and clinical outcomes in ninety patients undergoing intracranial tumor surgery and found that NS was associated with hyperchloremic metabolic acidosis and ionic hypocalcemia. RL caused significant hyponatremia and increase in serum lactate levels. The combination of NS and RL has the least influence on biochemical and metabolic parameters. Thus the NS group yield similar result.

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CONCLUSION

Ringer's lactate maintains a better physiological picture of acid-base balance and electrolyte variation in the intraoperative period.

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