Original Article

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Normal Saline versus Balanced Salt Solution in Diabetic Patients Undergoing Elective Surgery with Spinal Anaesthesia: A Randomised Control Study

Anaesthesia Section

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ABSTRACT

Introduction: Perioperative fluid management is of utmost importance in diabetic patients posted for surgery. Despite availability of a plethora of intravenous fluids, Normal Saline (NS) is still most commonly used in diabetic patients for perioprative fluid therapy.

Aim: The present study was designed to compare NS with plasmalyte to study their effects on blood sugar, serum electrolytes, lactate levels and blood pH in diabetes mellitus patients undergoing elective surgery under subarachnoid block.

Materials and Methods: The present double blinded randomised control study was carried out in the department of anaesthesiology and critical care at a Pt BDS PGIMS, Rohtak, Haryana, India, between November 2022 - April 2024. Seventy patients of age 30-85 years, with diabetes mellitus, American Society of Anaesthesiologists (ASA) class II scheduled for elective surgery under sub-arachnoid block were enrolled in a randomised controlled trial and randomly divided into two groups; Group A received NS and Group B received plasmalyte as intravenous fluid. Rest of the anaesthesia protocol was uniformly standardised in all the patients. Venous blood sample were drawn preoperatively, at one hour and six hours after the start of surgery for the measurement of blood sugar, serum sodium, potassium, chloride, serum lactate and pH. Recorded data was analysed with t-tests and Chi-square tests.

Results: Mean age was 60.66±13.56 years in NS group and 64.80±12.52 years in plasmalyte group. Serum lactate levels were comparable in preoperative (mean value 1.34±6.57 mmol\L in NS group and 1.14±0.48 mmol/L in plasmalyte group; p-value 0.12) and postoperative period at six hours time point (mean value of lactate (mmol/L) in Group A (NS) was 1.33±0.61 mmol/L in NS group and 1.17±0.38 mmol/L in plasmalyte group; p-value 0.18), but lactate levels were significantly lower in plasmalyte group (1.05±0.32) than in NS group (1.29±0.56) in intraoperative period with p-value of 0.03. Serum electrolytes, blood pH and glucose levels were comparable at preoperative, intraoperative and postoperative in both groups.

Conclusion: The present study results conclude that both plasmalyte and NS are comparable in maintaining blood sugar, serum electrolytes and blood pH perioperatively in patients with well optimised type II diabetes mellitus. However, plasmalyte is a promising alternative to 0.9% NS in terms of maintenance of lactate levels in diabetic patients.

Keywords: Blood sugar, Diabetes mellitus, Intravenous fluid, Lactate, Plasmalyte

INTRODUCTION

Perioperative fluid therapy is an important aspect of overall clinical management of surgical patients. Choice of perioperative fluid is determined by a host of factors with ultimate goal of maintaining or restoring tissue perfusion and minimising stress on patients physiological reservoir [1,2]. Perioperative fluid management is even more crucial for diabetic patients presenting for surgery as diabetes alters normal physiology in many ways and augments stress mechanisms hampering perioperative outcomes [3]. Therefore, maintaining normoglycaemia and preventing metabolic abnormalities such as fluid deficiencies, dyselectrolytemias, and acid-base disorders are of paramount importance in diabetic surgical patients [4].

The idea that physiologically Balanced Salt Solutions (BSS), as opposed to saline-based fluids, produces better clinical outcomes is getting wider support [5]. It has been found that BSS or plasmalyte has favourable metabolic profile in maintenance of plasma osmolality within the normal range. It has been found to cause less derangements in serum electrolytes and renal functions as compared to NS [6,7]. However, NS continues to be widely used despite various probable risks being associated with its use in diabetic surgical patients in the perioperative period [8,9].

There is paucity of literature regarding comparative studies of perioperative use of NS and BSS in diabetic patients operated under subarachnoid block. Thus, the present study was designed to evaluate effects of NS versus Isotonic BSS (plasmalyte) on blood sugar, serum electrolytes, lactate levels and blood pH in diabetes mellitus patients undergoing elective surgery under subarachnoid block to determine better solution at maintaining homeostasis in such patients.

MATERIALS AND METHODS

The present double blinded randomised control study was carried out in the Department of Anaesthesiology and critical care at a Pt BDS PGIMS, Rohtak, India, between November 2022 and April 2024. Following approval from institutional ethics committee (EC/NEW/INST/2022/HR/0189), this study was registered in clinical trial registry of India (CTRI/2023/05/052203 dated 02/05/2023).

Sample size calculation: Our sample size calculation was based on change in blood glucose levels among groups (mean difference of 2.77 with 3.9 Standard Deviation) as per study by Kaur N et al., [10]. Comparison of two mean formula: N=size per group; SD= Standard Deviation= 3.9, δ=mean difference=134.4-131.6=2.77; Zα/2= Z0.05/2=Z0.025=1.96 - From Z table at type I

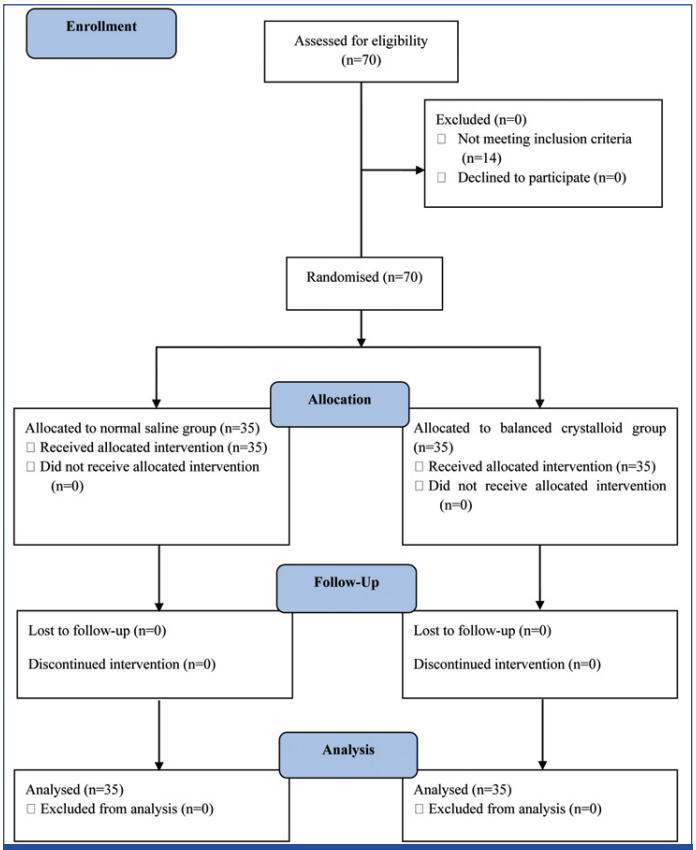
error of 5 and Zβ=Z0.20=0.84 - at 80% power. Formula used was- $N=2\times(Z\alpha/2+Z\beta)^2/(\delta0)^2\times SD^2=2$ (1.96+0.84)2 (3.9)2/(2.77)2.=30. Hence, Sample size was estimated to be 30 patients in each group. However, 35 patients were enrolled in each group to compensate for any potential loss to follow-up.

Inclusion and Exclusion criteria: Seventy patients of age group 30-85 years with well controlled diabetes mellitus, of either sex, belonging to American society of Anaesthesiologists (ASA) class 2, scheduled for elective surgery under spinal anaesthesia were included for this study. Exclusion Criteria included patient refusal, pregnant patients, patients with history of poorly controlled blood glucose levels, impaired renal or liver functions, patients receiving steroid therapy or diuretic, patients undergoing urological surgeries.

Study Procedure

During preanaesthetic checkup rounds, all the patients were examined in detail. Informed witnessed consent was taken from the patients for their participation in the study. Detailed clinical history were obtained and presence of any co-morbidity or ongoing drugs or medications were noted. Routine as well as special investigations necessary as per patient's requirement was obtained. Preoperative fasting of six hours prior to surgery for solids and two hours for clear liquids was ensured and no premedication was advised. A fasting, pre-operative venous sample for blood gas analysis was sent for all the patients on the morning of surgery and was treated as baseline for all biochemical study parameters i.e., blood sugar, serum electrolytes, serum lactate levels and pH.

Group allocation: The patients were randomly divided into two groups using computer-generated randomisation numbers in which a sequence of random numbers to be allocated to two equal groups was generated. Present study was an outcome assessor blinded study. Person recording venous blood sample reports and statistician analysing the records were kept blinded to group allocation. Group A (n=35) received NS while Group B (n=35) received isotonic balanced crystalloid (plasmalyte) intraoperatively and postoperatively till six hours from the beginning of surgery [Table/Fig-1].



[Table/Fig-1]: CONSORT flow diagram.

After group allocation, patients were shifted to operating room. All routine monitors such as Heart Rate (HR), Electrocardiogram (ECG), Non-Invasive Blood Pressure (NIBP), Pulse Oximetry (SpO_2) were attached and baseline vital parameters noted. Intravenous access was obtained using a wide bore cannula. The baseline blood glucose level was checked using an Accu-ChekTM glucometer and noted. Intravenous fluid administered as per group allocation. Rate and volume of fluids to be administered intraoperatively was as per the discretion of attending Anaesthesiologist of the individual surgery. Spinal anaesthesia was performed using standard technique and 0.5% hyperbaric bupivacaine given to all patients. Dose of hyperbaric bupivacaine given was, as per the discretion of the Anaesthesiologist in the operating room which was recorded. The surgery commenced after placing the patient in required position. The vital parameters {HR, Mean Arterial Pressure (MAP) and SpO_2} were monitored continuously and recorded at five minutes intervals for first 20 minutes and at 10 minutes interval thereafter.

Venous blood samples were drawn for blood gas analysis at one hour and six hours after the start of surgery for the measurement of blood sugar, serum sodium, potassium and chloride, serum lactate and pH. Blood glucose levels <70 mg/dL and >200 mg/dL, respectively were considered as hypoglycaemia and hyperglycaemia and were treated accordingly [11,12]. Any fall in HR or blood pressure by more than 20% of the baseline was recorded and treated accordingly, using standard protocol. Any drugs used, along with their doses were noted. Following completion of surgery, patients were shifted to Post Anaesthesia Care Unit (PACU) and the intravenous fluid continued as per group allocation @ 2 mL/kg/hr. Duration of surgery, intravenous fluid given, blood loss, blood transfusion (if any) were noted.

STATISTICAL ANALYSIS

The data were coded and entry into Microsoft Excel spread sheet was done. IBM Statistical Package for Social Sciences (SPSS) (SPSS Inc., IBM Corporation, NY, USA) Statistics Version 25 for Windows software program was used for data analysis. Descriptive statistics included calculation of percentages, means and standard deviations. The data were checked for normality before statistical analysis using Kolmogorov Simonov test. The unpaired t-test (for quantitative data to compare two independent observations) and paired t-test (for quantitative data to compare before and after observations) were applied. Clinical indicators were compared for qualitative data using Chi-square test. Level of significance was set at $p\leq0.05$.

RESULTS

Both groups had statistically comparable demographic profile (age, sex, weight, height), distribution of surgeries and comorbidities. There was no significant difference in baseline characteristics of preoperative serum electrolytes, glucose, pH, lactate along with mean anaesthetic dose used, mean crystalloid use, blood loss and transfusion, duration of surgery in both groups [Table/Fig-2].

Parameters	Group A Mean±Std. Deviation	Group B Mean±Std. Deviation	p-values
Age (years)	60.66±13.567	64.80±12.527	0.18
Gender	Male- 17	Male- 20	0.47
	Female-18	Female-15	
Distribution of surgeries	Orthopaedic-24	Orthopaedic-22	0.88
	General surgery-5	General surgery-6	
	Gynaecology-6	Gynaecology-7	
Distribution of comorbidities	COPD- 3	COPD- 2	0.84
	Hypertension-5	Hypertension- 4	
	Renal stone disease -1	Hypothyroidism- 1	
Weight (Kg)	69.89±9.526	67.14±11.469	0.28

Height (cm)	167.09±6.692	163.34±6.150	0.17
Drug dose (mL)	2.99±0.335	2.90±0.345	0.28
Total intraoperative crystalloid used (mL)	1317.73±350.521	1188.57±279.465	0.09
Blood loss (mL)	344.71±209.108	425.00±262.995	0.51
Blood transfusion	4 unit of PCV	1 unit of PCV and 1 unit of FFP	0.23
Duration of surgery (hours)	1.75±0.47	1.59±0.42	0.14

[Table/Fig-2]: Comparison of anthropometric profile and baseline characteristics of two groups.

Serum sodium, potassium, chloride levels and pH were found to be statistically similar between the two groups, NS vs PL at all subsequent time intervals preoperatively [Table/Fig-3], intraoperatively [Table/Fig-4], and postoperatively [Table/Fig-5]. Lactate levels were comparable at preoperative (mean value 1.34+6.57 mmol\L in NS group and 1.14+0.48 mmol/L in plasmalyte group; p-value 0.12 [Table/Fig-3], and postoperatively [Table/Fig-5], However lactate levels were higher in the NS group (1.29+0.56) than plasmalyte group (1.05+0.32) in intraoperative period with p-value of 0.03 [Table/Fig-4], though the values of lactate remained in physiological limits at all time periods. [Table/Fig-3-5]. Distribution of events of hyperglycaemia and hypoglycaemia [Table/Fig-6] and used doses of intravenous insulin and Dextrose Normal Saline (DNS), among both the groups were found to be comparable [Table/Fig-7]. None of the patient had any episode of nausea or vomiting. No episode of bradycardia, hypotension or hypoxia was recorded and HR [Table/Fig-8], MAP [Table/Fig-9] and SpO_2 [Table/Fig-10] were comparable in both group of patients.

Parameters	Group A Mean±Std. Deviation	Group B Mean±Std. Deviation	p-values
pH	7.37±0.04	7.37±0.06	0.91
Blood Glucose (mg/dL)	115.83±13.564	114.94±19.337	0.82
Serum Na (mEq\L)	135.86±5.06	135.91±4.298	0.95
Serum K (mEq\L)	4.06±0.49	3.905±0 .47	0.16
Serum Cl (mEq\L)	104.25±4.404	103.9±6.57	0.79
Serum Lactate (mmol/L)	1.34±0.56	1.14±0.48	0.12

[Table/Fig-3]: Comparison of venous blood gas parameters in two groups preoperatively.

Parameters	Group A Mean±Std. Deviation	Group B Mean±Std. Deviation	p-values
pH	7.37±0.04	7.37±0.05	0.65
Blood glucose (mg/dL)	138.74±51.597	120.23±40.464	0.09
Serum Na (mEq\L)	135.18±5.28	137.07±7.72	0.23
Serum K (mEq\L)	4.26±0.52	4.28±0.418	0.48
Serum Cl (mEq\L)	105.202±5.39	104.49±6.64	0.62
serum lactate (mmol/L)	1.29±0.56	1.05±0.32	0.03 (S)

[Table/Fig-4]: Comparison of venous blood gas parameters in two groups intraoperatively.

Parameters	Group A Mean±Std. Deviation	Group B Mean±Std. Deviation	p-values
pH	7.37±0.04	7.38±0.06	0.46
Blood glucose (mg/dL)	135.83±51.537	127.63±36.643	0.44
Serum Na (mEq\L)	135.12±4.87	135.86±7.14	0.61
Serum K (mEq\L)	4.26±0 .52	4.41±0.56	0.26
Serum Cl (mEq\L)	104.22±3.94	105.39±3.505	0.19
Serum Lactate (mmol\L)	1.33±0.61	1.17±0.38	0.18

[Table/Fig-5]: Comparison of venous blood gas parameters in two groups postoperatively.

Side-effects	Groups Group A N (%)	Group B N (%)	Total N (%)
Any side-effect	13 (37.1)	22 (62.9)	35 (50.0)
Hyperglycaemia	10 (28.6)	6 (17.1)	16 (22.9)
Hyperglycaemia-2 episodes	5 (14.3)	1 (2.9)	6 (8.6)
Hypoglycaemia	7 (20.0)	6 (17.1)	13 (18.6)
	35 (100)	35 (100)	70 (100)

[Table/Fig-6]: Comparison of side-effects between two groups. p-values=0.109

Treatment	Groups Group A N (%)	Group B N (%)	Total N (%)
Any side-effects	13 (37.1)	22 (62.9)	35 (50.0)
1 unit DNS	4 (11.4)	3 (8.6)	7 (10.0)
2 and 4 unit insulin respectively	2 (5.7)	1 (2.9)	3 (4.3)
2 unit insulin	8 (22.9)	3 (8.6)	11 (15.7)
4 units and 6 units insulin respectively	1 (2.9)	0 (0.0)	1.4 (6)
4 units insulin	3 (8.6)	3 (8.6)	6 (8.6)
6 units insulin	1 (2.9)	0 (0.0)	1 (1.4)
DNS (200mL)	2 (5.7)	1 (2.9)	3 (4.3)
DNS (300mL)	1 (2.9)	2 (5.7)	3 (4.3)
	35 (100)	35 (100)	70 (100)

[Table/Fig-7]: Comparison of the treatment for side-effects between two groups. p-value=0.49

HR Time interval	Group A Mean±Std. Deviation	Group B Mean±Std. Deviation	p-values
Baseline	81.28±6.64	81.11±7.31	0.91
5 min	78.4±6.34	78.37±6.44	0.98
10 min	75.14±5.96	74.77±6.18	0.79
15 min	78.25±6.02	78.45±6.15	0.89
20 min	81.54±5.82	81.14±6.38	0.78
30 min	80.6±5.12	81.45±4.70	0.46
40 min	79.45±5.89	80.2±4.90	0.56
50 min	80.31±5.97	79.85±5.13	0.73
60 min	79.57±6.26	78.68±5.587	0.53
70 min	79.8±5.80	79.45±5.62	0.80
80 min	80.03±5.85	79.92±5.17	0.94
90 min	80.89±5.42	80.6±5.53	0.84
100 min	79.56±5.03	79.2±5.43	0.82
110 min	79.77±5.47	78.53±6.05	0.55
120 min	80±5.68	76.22±4.96	0.10
130 min	79.56±6.28	74.42±4.50	0.06
140 min	79.57±3.77	73±4.35	0.04

[Table/Fig-8]: Comparison of Heart Rate (HR) between two groups at different time interval.

MAP Time interval	Group A Mean±Std. Deviation	Group B Mean±Std. Deviation	p-values
Baseline	83.40±6.60	83.20±6.69	0.90
5 min	77.02±5.49	76.91±4.94	0.92
10 min	79.88±5.29	79.91±5.34	0.98
15 min	82.48±6.50	82.57±5.98	0.95
20 min	83.31±5.41	82.97±6.10	0.80
30 min	82.91±4.91	83.4±5.51	0.69
40 min	83.31±4.29	83.48±4.98	0.87

50 min	84.34±3.92	83.97±4.79	0.72
60 min	82.8±3.62	83.85±3.84	0.24
70 min	82±3.44	82.72±3.56	0.39
80 min	83±3.47	84.16±3.04	0.20
90 min	82.89±3.38	83.62±3.44	0.44
100 min	83.17±3.90	82.10±3.22	0.34
110 min	83.83±3.71	82.30±3.92	0.27
120 min	83.94±3.52	83.30±4.34	0.67
130 min	83.93±3.90	84±3.74	0.97
140 min	84.14±2.96	83.66±4.93	0.85

[Table/Fig-9]: Comparison of Mean Arterial Pressure (MAP) between two groups at different time interval.

SpO2 Time interval	Group A	Group B	p-values
	Mean±Std. Deviation	Mean±Std. Deviation	
Baseline	97.91±2.34	97.91±2.29	
5 min	100±0	100±0	
10 min	100±0	100±0	
15 min	100±0	100±0	
20 min	100±0	100±0	
30 min	100±0	100±0	
40 min	100±0	100±0	
50 min	100±0	100±0	
60 min	100±0	100±0	1
70 min	100±0	100±0	
80 min	100±0	100±0	
90 min	100±0	100±0	
100 min	100±0	100±0	
110 min	100±0	100±0	
120 min	100±0	100±0	
130 min	100±0	100±0	
140 min	100±0	100±0	

[Table/Fig-10]: Comparison of SpO2 between two groups at different time interval.

DISCUSSION

The present study was designed as an outcome assessor blinded, randomised controlled trial to compare the effects of the two crystalloids: NS and BSS, on blood sugar, serum electrolytes, lactate levels and blood pH in diabetes mellitus patients undergoing elective surgery, under subarachnoid block.

In present study, blood glucose levels in the preoperative period, intraoperative period, and postoperative period were found to be comparable with no statistically significant difference in both groups. Kaur N et al., did a similar study for comparing effect of Ringer's lactate and 0.9% NS on blood glucose levels in fasting, diabetic surgical patients under spinal anaesthesia and found no visible difference in the mean blood glucose levels both pre operatively and after infusion of crystalloids between the two study groups. However, there study did not include BSS [10]. Billiodeaux ST et al., retrospectively examined anaesthetic and surgical records of type 2 diabetic patients undergoing carotid endarterectomy for the impact of lactated Ringer's (LR) and NS on blood glucose control during and after surgery [13]. The difference in the mean change in glucose between the two groups was not statistically significant. The present study results are similar to this study, however, there are some notable differences between the two studies as patients were operated under general anaesthesia and RL and NS were compared. Koti VR et al., evaluated the change in blood sugar levels using NS as intravenous fluid during surgeries under various anaesthetic techniques and found that regional anaesthesia techniques are more beneficial for diabetic population in reducing stress response and in turn providing better glycaemic control [14].

Present study found no statistically significant change in serum electrolytes in both groups at all-time intervals of preoperatively, at one hour from the starting of the surgery and at six hours from the starting of the surgery. Mc Farlane C and Lee A compared NS and plasmalyte in patients undergoing major hepatobiliary and pancreatic surgeries [15]. The investigators found that patients receiving NS had significantly higher chloride concentration while serum potassium and serum sodium concentrations were comparable. They concluded that using NS as the sole intravenous fluid during surgery can result in hyperchloremic acidosis and using a BSS, like plasmalyte, can help prevent these side effects. The reason for different results in chloride concentrations in their study is probably due to larger volumes of total fluid infused. It is noteworthy that their study involved patients undergoing major surgeries under general anaesthesia with major fluid shifts. Chatrath V et al., compared plasmalyte A and NS in elective abdominal surgeries and observed that mean change in serum sodium level was higher in NS group as compared to plasmalyte A group [16]. Variations in serum potassium levels were within physiological limits whereas variations in serum chloride levels were significantly higher in immediate postoperative period in NS group as compared to plasmalyte A group. However, after 24 hours, there was no visible difference between the two groups. Neither NS nor plasmalyte A had an effect on the long-term electrolyte profile. The difference in observations as compared to our study may be due to their prolonged follow-up, as well as the cohort of patients undergoing major abdominal surgeries that involve major fluid shifts, under general anaesthesia. Huang L et al., conducted a meta-analysis to evaluate the safety of NS versus balanced crystalloids in adult patients undergoing non-renal surgery [17]. They observed that the patients in the balanced crystalloids group had significantly lower postoperative serum chloride levels as compared to NS group. They found that balanced crystalloids is superior in the maintenance of postoperative electrolytes in adult patients undergoing non-renal surgery. Song JW et al., evaluated effects of plasmalyte versus NS in patients undergoing lumbar spinal surgery under general anaesthesia [18]. They observed that serum chloride concentrations were significantly higher, even in the postoperative period, in the NS group. However, no significant differences were observed between the two groups in terms of sodium level. The results are contrary to our study in terms of chloride, may be because of the difference in the mean volume of fluid infused in both studies, 2-4 litres versus 1-1.5 litres in the present study. Dey A et al., compared NS and BSS in patients undergoing elective craniotomy and observed higher chloride levels at 2, 4, 6 and 8 hour after induction and higher sodium levels in NS group than BSS group, though there was no significant difference in serum sodium values between the two groups [19]. The study findings demonstrated that BSS is more advisable to maintain the electrolytes balance within the physiological limits in patients undergoing neurosurgery.

In present study, there was no significant difference in pH in both groups at all-time intervals. Serum lactate levels were comparable in both groups at preoperatively and postoperatively, However, a significant difference in lactate levels was noted between the groups (NS>BSS; p=0.03) at one hour time point intraoperatively, though the lactate levels were within the normal physiological limits in all the patients. Self AH et al., conducted a study to compare the clinical effects of balanced crystalloids with NS for the acute treatment of adults with Diabetic Ketoacidosis (DKA) [20]. They revealed shorter time to DKA resolution in the balanced crystalloids group than the saline group. Cumulative incidence analysis also revealed shorter time to insulin infusion discontinuation in the balanced crystalloids group which suggests that BSS is a better crystalloid for restoration and maintenance of homeostasis in diabetic patients even with uncontrolled glycaemic status. Young JBL et al., compared these two crystalloids for the initial resuscitation of trauma patients and noted a more favourable acid base status in those who received BSS [21].

Their study patients were in acidosis at baseline. Patients remained acidemic in NS group after six hours of resuscitation whereas pH returned to normal in BSS group after initial phase of resuscitation. Selection of trauma patients, lack of time for optimisation, more blood transfusions, major fluid shifts and longer duration in their study might have resulted in different observation as compared to the present study. Curran Jeffrey D et al., conducted a systematic review and meta-analysis in 24 randomised controlled trials for the comparison of plasmalyte with another crystalloids like Ringer's lactate, Ringer fundin, hartmann's solution, Ringer's bicarbonate, sterofundin, kabilyte, normosol, and novel balanced solutions [22]. Administration of plasmalyte resulted in a lower post infusion serum lactate levels compared with administration of any other balanced crystalloid in their study. Arora V et al., conducted a study to compare the effect of NS versus plasmalyte on coagulation and metabolic status in patients undergoing neurosurgical procedures and their results showed that the pH was significantly lower (acidosis) in the NS group as compared to the PL group at four hours after surgery [23]. They suggested that, use of PL had a superior acid–base and renal profile in these patients. Zhou F et al., investigated the effect of NS versus a BSS (plasmalyte) in a Cecal Ligation and Puncture (CLP) model of sepsis in animals. Saline-treated animals developed both significantly lower pH and higher lactate levels as compared to BSS group, whereas both groups had normal lactate levels in the beginning [24].

The present study has similar results in terms of the lactate levels with significantly higher lactate in NS groups versus BSS group, when lactate levels were similar and within the normal range in both groups at beginning of the study. The exact mechanisms causing this change are not clear, however as per literature there is a possible explanation. Chloride content is higher in NS than plasmalyte. Presence of chloride is responsible for stabilisation of HbH+ which is formed in blood by avid binding of hydrogen ions with deoxygenated hemoglobin. The role of chloride is important physiologically as it is a heterotropic, negative, allosteric effector of haemoglobin that competes for the binding to 2,3 bisphosphoglycerate and, is accountable for decreased affinity of oxygen for haemoglobin. This phenomenon negatively affects oxygen delivery to the tissues, mimicking anaerobic metabolism, which results in more lactate production [25,26]. Further studies with large sample sizes, more volumes of fluids transfused with more extensive follow ups and monitoring are required to understand and confirm this finding and its relevance to the clinical management.

In the present study, none of the patients in either group suffered from nausea and vomiting. Few patients in each group had hyperglycaemia and hypoglycaemia, however their numbers were comparable and statistically insignificant. In the present study, both groups received statistically comparable volumes of intravenous fluid and blood transfusion and there were no major fluid shifts owing to limited duration of surgery. Massive blood transfusion or fluids could have impacted serum electrolytes, pH and lactate levels [27,28].

Further studies with larger sample sizes, more volumes of fluids transfused, more extensive follow ups and monitoring are desirable to validate this finding and its relevance to the clinical management. So, this study may be considered as a pilot study for further research in pursuit of finding the optimal intravenous fluid for perioperative use in diabetes mellitus patients.

Limitation(s)

Present study included patients scheduled for elective surgeries under spinal anaesthesia, Hence, excluding major cavity (intra-abdominal, intra-thoracic) surgeries with major fluid shifts which are mostly conducted under general anaesthesia. Our observation period was only six hours while longer duration of observation may have been more insightful. Other renal function parameters like urea, creatinine and Neutrophil Gelatinase-Associated Lipocalin (NGAL) were not observed in present study. We could not measure serum osmolality as it was not available in our venous blood gas analysis parameters. Present study did not include patients undergoing emergency surgeries where the basal parameters may not be well controlled.

CONCLUSION(S)

Present study found serum sodium, potassium, chloride levels and pH to be statistically similar between the two groups of NS and plasmalyte in well optimised type II diabetes mellitus for elective surgeries under subarachnoid block, at preoperative, intraoperative and postoperative time periods. Serum lactate levels were comparable in both groups at preoperative and postoperative time period but higher in NS group in intraoperative period. We conclude that both plasmalyte and NS (0.9%) are comparable in their effects on blood sugar and serum electrolytes and may be safely used perioperatively in patients with well optimised type II diabetes mellitus for elective surgeries. However, plasmalyte is marginally better and a promising alternative to 0.9% NS in terms of maintenance of lactate levels in diabetic patients.

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