Section: Anaesthesiology and Critical Care

Original Research Article

EFFICACY OF CHLORIDE RESTRICTIVE VERSUS CHLORIDE LIBERAL FLUID STRATEGY IN NEUROSURGICAL PATIENTS AND ITS IMPACT ON ACID BASE BALANCE

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Abstract

Background: The fluid management of neurosurgical patients presents special challenges for anaesthesiologist. For a long time restrictive management has been treatement of choice in patients with brain pathology. The goal to aim for seems to be "normo-everything": normovolemia, normoglycemia and normonatremia. **Materials and Methods:** This was a retrospective observational study carried out in Forty four patients ,aged 18-60 yrs either gender of American Society of anaesthesiologist (ASA) Physical status class I to III undergoing elective neurosurgical surgeries under general anaesthesia with duration more then 2 hours .Group R chloride restrictive received plasmalyte and Group L chloride liberal received0.9%NS, Primary Objective to evaluate the difference in acid base status and secondary Objective to evaluate the difference in electrolyte level ,lactate level and urine output in neurosurgical patients. **Result:** Significantly higher mean lactate and chloride levels in Group L and significantly lower potassium and pH levels at multiple time points in Group L. Base excess, sodium levels, urinary output, bicarbonate levels were comparable in both the groups. **Conclusion:** We suggest using plasmalyte therapy in patients undergoing elective neurosurgical procedures as this is associated with lesser incidence of hypokalemia, hyperchloridemia, hyperlactatemia and lower pH levels.

INTRODUCTION

Brain injuries remain a major concern for public health services, particularly because of the high mortality rate and long-term disabilities.[1] In the early stages of caring for brain-injured patients, therapies are focused on minimizing secondary brain injuries that are centrally involved in determining outcomes.[2] Intracranial hypertension (ICH) is the most frequent cause of death and secondary brain insults after brain injury.[3] The maintenance of adequate cerebral perfusion pressure (CPP), which is associated with control of intracranial pressure (ICP), is the cornerstone of treating the ion deficit associated with brain ischaemia in brain-injured patients. Infusion of hypo-osmotic solutions, which increases cerebral swelling, should be avoided after brain injury.[4,5]

Current recommendations are to use isotonic solutions in patients with severe brain injury.[6,7] with isotonic sodium chloride (0.9% saline solution) being the mainstay of therapy. Isotonic sodium chloride solutions induce hyperchloraemic metabolic acidosis and have side effects including haemostatic alterations, cognitive dysfunction and ileus.[8] Hyperchloraemia is relatively common in critically ill patients, and it is now commonly accepted that chloride rich fluids are the primary cause of hyperchloraemic acidosis in critically ill patients.[9] In a before-after study, a chloride-restrictive strategy was associated with a significant decrease in renal failure in critically patients and significantly affected electrolyte and acid-base status.[10]

In a post hoc analysis of a retrospective study in TBI patients receiving isotonic sodium chloride solutions for basal infusion.[11] 65% of the patients

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experienced hyperchloraemia. Chloride channels regulate cell oedema.[12] and it could be hypothesised that dyschloraemia contributes to brain swelling. Isotonic balanced solutions are now available and include crystalloids as well as hydroxyethyl starch (HES) solutions. In these isotonic solutions, the use of malate and acetate allows the reduction of chloride concentration while ensuring isotonicity. Balanced solutions could thus reduce the incidence of hyperchloraemic metabolic acidosis. Balanced solutions decrease the rate of hyperchloraemic acidosis in healthy volunteers.[13,14] and during perioperative care compared with saline solutions.[15] In our study we intented to find out the he effectiveness of maintaining acid base balance, electrolyte and lactate level in patients undergoing neurosurgical procedures with either 0.9% normal saline or balanced salt solution.

MATERIALS AND METHODS

After approval from the institutional ethical committee, this is single blinded, prospective randomized control study. Conducted from Dec 2018 to Jun 2020 in tertiary care hospital. The participant included are adult patients aged 18-60 years of either gender belonging to American Society of anaesthesiologist (ASA) Physical status class I to III undergoing elective neurosurgical surgeries under general anaesthesia with duration more then 2 hours. Patients excluded are emergency neurosurgical procedures, less than 500 mL of infusion, duration of surgery less than 2 hours, preexisting renal or cardiac diseases, use mannitol preoperatively, pre-existing electrolyte abnormalities and ASA physical status IV or greater. The demographic data including age, body weight in Kg, ASA physical status, vital parameters NIBP, heart rate, SpO2 will be recorded in preoperative room. Pre-operatively sample of blood were withdrawn and send for serum electrolytes, this were taken as baseline parameter for electrolytes. The patients will be randomized in two groups of 22 each. The first group will be designated as group R receiving plasmalyte solution. Second group will be group L receiving 0.9% Normal saline. On arrival in the operation theatre, arterial line and intravenous line was secured. Minimum mandatory monitoring was applied which includes Heart Rate, NIBP, SpO2 and ECG. All patients were pre-oxygenated with 100% oxygen for 3-4 minutes and following drugs will be administered as per standard general anaesthesia protocol Inj. Glycopyrolate 0.2 mg IV, Inj Fentanyl 2 mg/Kg IV,Inj.Propofol 2 mg/Kg IV, Inj.Atracurium 0.5 mg /Kg IV. After Inj. Atracurium, the patient were intubated with standard cuffed ETT appropriate to age and sex. Maintenance by sevoflurane with 1 MAC Ventilation was mechanically controlled to maintain end tidal pressure 30-34 mm of Hg. As per randomization, the patients received either 0.9% normal saline or balanced salt solution, as per randomization protocol. Inj.Mannitol 1gm/kg was given at first burrhole in over 20 min. ABG sample was collected with the start of the surgery, the first sample was baseline and every two hours, at the end of surgery and 6 hours after surgery was taken for analysis.pH,HCO3,base excess ,Na+ ,K+ ,Cl- ,serum electrolytes ,urine output were compared between the two groups at the various time points.

RESULTS

The basic demographic data including age, ASA class were insignificant between the studied groups. Base excess and bicarbonate levels are comparable among the studied groups.

Chloride levels are comparable at baseline but statistically significant and higher at 2nd and 4th hour normal saline group as compared to plasmalyte Group (P =0.01) [Table 1 & Figure 1].

Table1: Comparison of chloride

Chloride (mEq/L)	Plasmalyte group		Normal saline group		P value
	Mean	SD	Mean	SD	
Base Line	107.22	4.04	108.30	4.11	0.35
2 hourly	102.36	5.78	106.08	4.48	0.01
4 hourly	103.00	6.81	107.08	3.89	0.01
6 hourly	106.49	4.05	102.10	2.97	0.22
End of surgery	111.40	4.85	110.80	1.13	0.85
6 h-Post Op	107.44	4.33	108.60	8.36	0.54

Significantly higher levels(P<0.02) of chloride at 2nd hour and 4th hour of surgery in normal saline group as compared plasmalyte group.

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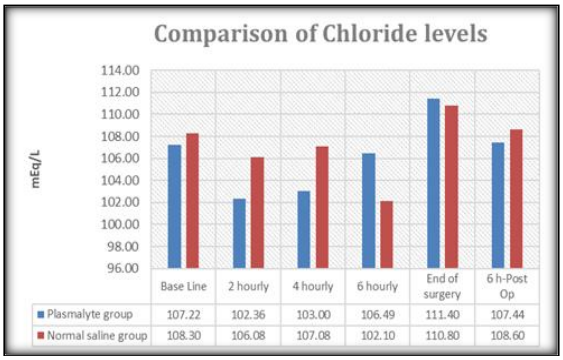

Figure 1: Comparison of Cholride levels

Potassium levels are comparable at baseline in both the groups but significantly lower in normal saline group at 2nd,4th and 6th hour as compared to plasmalyte group(P<0.001,0.03,0.02) [Table 2 & Figure 2].

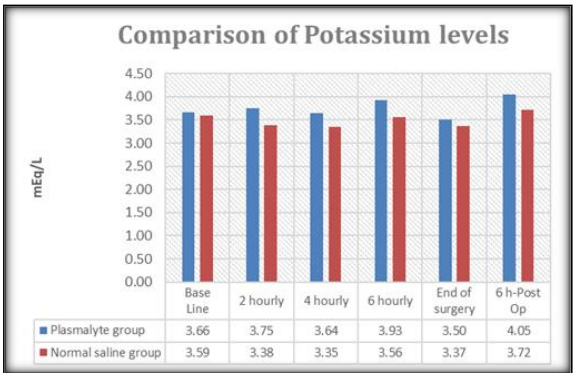

Figure 2: Comparison of Potassium Levels

Table 2: Comparison of Potassium levels

Potassium (mEq/L)	Plasmalyte group		Normal saline group		P value
	Mean	SD	Mean	SD	
Base Line	3.66	0.48	3.59	0.36	0.59
2 hourly	3.75	0.34	3.38	0.51	**P<0.001**
4 hourly	3.64	0.48	3.35	0.47	**0.03**
6 hourly	3.56	0.24	3.93	0.10	**0.02**
End of surgery	3.50	0.50	3.37	0.19	0.70
6 h-Post Op	4.05	0.53	3.72	0.57	0.04

The P value was significant at 2nd hour, 4th hour and 6th hour into surgery with P value of <0.001, 0.03, 0.02 respectively suggesting significantly higher incidence of lower potassium levels in normal saline group.

Table 3: Comparison of lactate levels

Lactate (mmol/L)	Plasmalyte group		Normal saline group		P value
	Mean	SD	Mean	SD	
Base Line	1.84	0.44	2.02	0.33	0.13
2 hourly	1.74	0.65	2.03	0.28	0.047
4 hourly	1.84	0.69	2.22	0.45	0.03
6 hourly	1.76	0.40	1.60	0.71	0.81
End of surgery	1.20	0.17	1.65	0.64	0.49
6 h-Post Op	1.82	0.68	2.26	0.23	P<0.001

The P value was significant at 2nd hour, 4th hour into surgery and 6th hour post operatively with P value of 0.047, 0.03, <0.001 respectively suggesting significantly higher lactate levels in normal saline group.

Table 4: Comparison of pH

pH	Plasmalyte group		Normal saline group		P value
	Mean	SD	Mean	SD	
Base Line	7.41	0.03	7.43	0.04	0.17
2 hourly	7.40	0.05	7.36	0.09	0.03
4 hourly	7.40	0.08	7.34	0.10	0.02
6 hourly	7.45	0.03	7.24	0.10	0.019
End of surgery	7.41	0.02	7.41	0.08	0.99
6 h-Post Op	7.40	0.03	7.36	0.08	0.03

The P value was significant at 2nd hour, 4th hour, 6th hour into surgery and 6th hour post operatively with P value of 0.03, 0.02, 0.019 and 0.03 respectively suggesting significantly lower pH levels in normal saline group.

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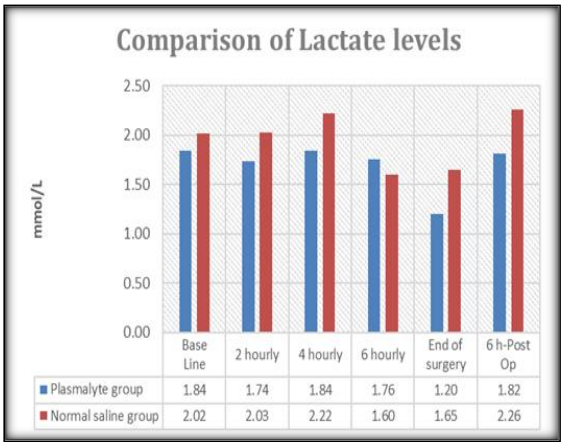

Figure 3: Comparison of Lactate Levels

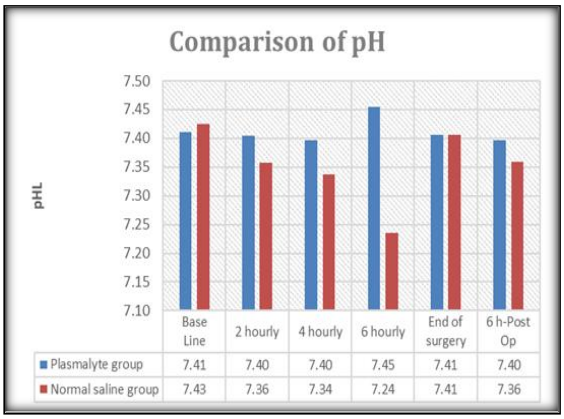

Figure 4: Comparison of pH

DISCUSSION

In our study we found base excess and bicarbonate levels in plasmalyte group and normal saline group were comparable.

Chloride levels is statistically significantly higher at 2nd hour and 4th hour of surgery in normal saline group as compared to plasmalyte group (P =0.01) in our study. Roquilly A et al.[16] conducted a single-centre, two-arm, randomised, double-blind, pilot controlled trial in patients with severe traumatic brain injury and noted that balanced solutions reduce the incidence of hyperchloraemic acidosis in brain-injured patients compared to saline solutions. Dey A et al.[17] conducted a prospective, randomized controlled trial on patients undergoing elective craniotomy noted that Hyperchloremic metabolic acidosis, and the other problems which occur as a consequence of normal saline infusion may be circumvented by choosing a balanced crystalloid electrolyte solution. Lima MF et al.[18] concluded in a study that balanced crystalloids induce less chloride and metabolic derangements than 0.9% saline solutions in children. Lehmann L et al.[19] noted that treatment with saline-based fluids resulted in a greater number of patients with hyperchloremia while administration of balanced solutions did not.

Potassium levels in normal saline group is significantly higher incidence of lower potassium levels as compared to plasmalyte group at 2nd hour, 4th hour and 6th hour of surgery with P value of <0.001, 0.03, 0.02 respectively. Because of the potential electrolyte losses following the use of diuretics and mannitol, frequent determination of serum sodium and potassium should be made. It may be necessary to replace potassium intraoperatively. Hyponatremia and hypokalemia may both lead to a delayed return to consciousness postoperatively.[109] Hassan MH et al.[21] in a study noted that in 66 traumatic brain injury patients that use of normal saline was associated with significant hypokalemia (3.36 versus 3.70 mmol/L, P< 0.001) than the BF group at 24 h of therapy. In our study we found significantly higher lactate levels in Normal saline as compared to plasmalyte group at 2nd hour, 4th hour into surgery and 6th hour post operatively with P value of 0.047, 0.03, <0.001 respectively. Hassan MH et al.[21] compared the changes in electrolytes and acid-base between Normal saline and balanced solution group. They however noted non-significant difference between the groups for lactate levels between the two groups. Evaluation of sodium levels in plasmalyte group and normal saline group were comparable in our study. Lehmann L et al.[19] noted that administration of balanced solutions is not associated with increased risk of hyponatremia. Hassan MH et al.[21] noted that no significant differences were found in pH, pCO2, lactate, and sodium level in groups receiving either normal saline or balanced solution.

In our study significantly lower of pH levels in normal saline group compared to plasmalyte group. The P value was significant at 2nd hour, 4th hour, 6th hour into surgery and 6th hour post operatively with P value of 0.03, 0.02, 0.019 and 0.03 respectively. Dey A et al. [17] noted that balanced crystalloid maintains metabolic status more favorably than normal saline in neurosurgical patients. Hyperchloremic metabolic acidosis, and the other problems which occur as a consequence of normal saline infusion may be circumvented by choosing a balanced crystalloid electrolyte solution.Roquilly A et al.[16] noted that In the saline group, pH (P = .004) and strong ion deficit (P = 0.047) were lower compared to balanced group.Evaluation of urinary output in plasmalyte group and normal saline group were comparable As a general rule, intraoperative fluid administration should be given at a rate sufficient to replace the urinary output and insensible losses. There were no incidences of renal injury in our study leading to oliguria/anuria and rise in creatinine levels. Bellomo R et al.[20] noted that implementation of a chloride-restrictive strategy in a tertiary ICU was associated with a significant decrease in the incidence of AKI.

CONCLUSION

As observed from our study there was higher instance of mean chloride levels, significantly

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higher mean lactate levels and potassium, pH levels were significantly lesser in normal saline group at multiple time points. Base excess, sodium levels, urinary output, bicarbonate levels were comparable between the groups. We suggest using plasmalyte therapy in patients undergoing elective neurosurgical procedures as this is associated with lesser incidence of hypokalemia, hyperchloridemia, hyperlactatemia and lower pH levels.

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Nil

Conflicts of interest

There is no conflict of interest.

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