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Original Article

Anaesthesia Section

Impact of Intraoperative Colloid versus Crystalloid Administration on Postoperative Outcomes in Major Gastrointestinal Surgeries: An Interventional Study

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ABSTRACT

Introduction: Colloids and crystalloids are frequently used for fluid resuscitation. However, their differing physiological properties may impact postoperative outcomes in distinct ways. Emerging evidence indicates that these variations could play a role in influencing surgical morbidity.

Aim: To evaluate the impact on postoperative outcomes using crystalloids and colloids intraoperatively in patients undergoing major surgeries.

Materials and Methods: This double-blinded, interventional study was conducted from July 2019 to December 2020 at Department of Anaesthesiology, Uttar Pradesh University of Medical Sciences (UPUMS), Saifai, Etawah, Uttar Pradesh, India. A total of 150 patients, aged 16-60 years, American Society of Anaesthesiologists (ASA) Grade I, II and III, undergoing elective major surgery were enrolled in the study and divided into three groups, with 50 patients per group: group RL (n=50), Group Hetastrach and Ringer's Lactate (HS-RL) (n=50) and Group Tetrastarch and Ringer's Lactate (TS-RL) (n=50). All patients received Ringer's Lactate (RL) at a rate of 7.0 mL/kg/hour before induction. Intraoperatively, group RL received Ringer's Lactate alone at a rate of 8.0 mL/kg/hour, group HS-RL received both Ringer's Lactate and 6% hetastarch at a rate of 8.0 mL/kg/hour and group TS-RL received 6% tetrastarch and Ringer's Lactate at a rate of 8.0 mL/kg/hour. The patients were observed for 8 days postoperatively for vital signs, Arterial Blood Gas (ABG) analysis, ambulation, Postoperative Nausea and Vomiting (PONV) and complications. The data were represented as mean standard deviations and percentages and analysed using the Statistical Package for Social Sciences (SPSS) version 20.0. A p-value of <0.05 was considered statistically significant.

Results: Two patients were excluded from the study due to missing data in group RL (n=48). The demographic characteristics were statistically not significant among the groups (p-value>0.05). The proportion of patients who could ambulate independently or with assistance was higher in the HS-RL group 23 (46%) patients compared to the TS-RL group 16 (32%) patients, followed by patients in group RL (3 patients, 6.25%) (p-value <0.05). Intravenous fluids were administered to most patients for five days. Statistically, there was no significant difference among the groups (p-value=0.230). The data were represented as mean standard deviations and percentages and analysed using SPSS version 20.0. A p-value of <0.05 was considered statistically significant.

Conclusion: Colloids are superior to crystalloids in terms of independent ambulation, ambulation with assistance, temperature regulation and reduction of nausea and vomiting. Overall, the present study concluded that colloids are able to effectively reduce postoperative complications more effectively than crystalloids without any serious side-effects.

Keywords: Arterial blood gas analysis, Hetastarch, Ringer's lactate, Tetrastarch

INTRODUCTION

Clinical studies have shown that colloids and crystalloids have different effects on a range of important physiological parameters [1]. Hypovolaemia is one of the most common and potentially reversible crises in acute medicine [2]. In the daily routine of intensive care, we continually monitor hypovolaemia through vital signs such as Blood Pressure (BP) and Pulse Rate (PR), as well as by monitoring end-organ function such as urine output and peripheral perfusion. Even a minor degree of hypovolaemia can cause ischaemia and organ dysfunction [3].

There are inherent differences between colloids and crystalloids that may contribute to their effects. The choice of fluid has considerable cost implications; volume replacement with colloids is significantly more expensive than with crystalloids. Several meta-analyses have failed to demonstrate a clear advantage in the use of colloids over crystalloids [4,5]. In a large surgical population undergoing a diverse group of routine, moderate-risk elective surgeries, it has been demonstrated that the incidence of postoperative complications, defined as either in-hospital death or prolonged postoperative hospitalisation (greater than 7 days), was 27% [6].

The administration of colloids as a plasma volume expander during the intraoperative period is associated with improved outcomes and a reduction in hospital stay [7,8]. However, the administration of large volumes of 6% hetastarch in saline can cause coagulation abnormalities and lead to electrolyte imbalances, such as hyperchloraemic acidosis, due to the high chloride content. Goal-directed plasma volume expansion is associated with improved outcomes and a reduction in hospital stay for patients undergoing major surgical procedures [9]. The success of haemodynamic resuscitation depends on an integrated and comprehensive strategy aimed at identifying and treating the primary cause of shock, careful assessment and reassessment and minimising iatrogenic harm [10]. It is safe to administer a balanced crystalloid as the maintenance fluid and to use a colloid, such as HES130/0.4, 4% gelatin, or human albumin, as a volume expander [11].

In intensive care, large randomised controlled trials have suggested that Hydroxyethyl Starches (HES) are associated with a higher

incidence of complications [12,13]. Colloid-based goal-directed fluid therapy was associated with fewer postoperative complications than crystalloid therapy. This beneficial effect may be related to a lower intraoperative fluid balance [14]. Using a goal-directed haemodynamic algorithm to optimise stroke volume, a balanced HES solution is associated with better haemodynamic stability and a reduced need for fresh-frozen plasma [15].

We prospectively observed a diverse group of surgical patients and systematically assessed them for morbidity using predefined criteria. As a secondary objective, we tested the hypothesis that intraoperative indices of tissue hypoperfusion (e.g., analysis of arterial blood gases) are good predictors of operative morbidity. The present study aimed to evaluate the impact on postoperative outcomes using crystalloids and colloids intraoperatively in patients undergoing major surgeries. The primary objective was to compare the impact of intraoperative colloid versus crystalloid fluid administration on postoperative outcomes. The secondary objective was to evaluate intraoperative indices of tissue hypoperfusion (e.g., analysis of arterial blood gases) as predictors of postoperative morbidity.

MATERIALS AND METHODS

The present double-blinded (both patient and researcher blinded), interventional study was conducted from July 2019 to December 2020 at Department of Anaesthesiology, Uttar Pradesh University of Medical Sciences (UPUMS), Saifai, Etawah, Uttar Pradesh, India. Ethical clearance for this study was obtained from the Institutional Ethical Committee (Ethical Clearance No. 2019/15).

Sample size calculation: It was performed assuming a 5% significance level with a 95% confidence interval and a power of 80%, using Statistical Package for Social Sciences (SPSS version 20.0) software (IBM Corporation, Armonk, New York, USA). The calculated sample size amounted to 150 patients (50 patients per group). Randomisation was carried out using a computer-generated random number table.

Inclusion and Exclusion criteria: All adult patients classified as American Society of Anaesthesiologists (ASA) physical status I, II and III, scheduled to undergo elective surgical procedures in gastroenterology, including hepatobiliary surgery, were included. Patients with coagulopathy, hepatic dysfunction, renal dysfunction, Congestive Heart Failure (CHF), or known hypersensitivity to hydroxyethyl starch were excluded from the study. Additionally, patients receiving investigational drugs within 30 days prior to the study were also excluded.

Study Procedure

A total of 150 patients, classified as American Society of Anaesthesiologists (ASA) physical status I, II and III, scheduled to undergo elective major gastrointestinal surgeries, were recruited for this study. All the patients were informed about the procedure and written informed consent was obtained. They were randomly divided into three groups, with 50 patients in each group.

Group RL (n=50): Patients in this group received Ringer's lactate during the intraoperative period.

Group HS-RL (n=50): Patients in this group received both Ringer's lactate and 6% hetastarch during the intraoperative period.

Group TS-RL (n=50): Patients in this group received both Ringer's lactate and 6% tetrastarch during the intraoperative period.

Patients in all groups were administered fluids at a rate of 8 mL/kg/hr during the intraoperative period. All patients were premedicated with a tablet of lorazepam 1 mg orally the night before surgery and a tablet of ranitidine 150 mg one hour prior to surgery, with a sip of water. Upon entering the operating room, standard ASA monitoring, such as 12-lead Electrocardiogram (ECG), Non Invasive Blood Pressure (NIBP) and SpO_2, was attached and recorded. Patients in all groups received Ringer's lactate at a rate of 7.0 mL/kg/hour before the induction of anaesthesia. The induction of anaesthesia was accomplished using propofol 2.5 mg/kg, fentanyl 3.0 µg/kg and vecuronium 0.08-0.10 mg/kg.

All patients were maintained with a standard general anaesthesia protocol. Intravenous fluids were administered according to the allocated group protocol. The volume of extra fluid required was based on a goal-directed fluid therapy algorithm: if the Mean Arterial Pressure (MAP) was less than 65 mmHg, Central Venous Pressure (CVP) was assessed; if CVP was less than 8 mmHg, fluid was given to raise CVP to 12 mmHg. If MAP was above 65 mmHg, no further fluid resuscitation was performed. After the completion of surgery, patients were transferred to the postoperative ward. All patients were observed for up to eight days postoperatively by the same person.

The patients were first observed two hours after being shifted to the postoperative ward; this observation was considered to be the Day 1 observation. The Day 2 observation was made the following day at 10:00 AM and subsequent observations were made at the same time each morning for the following days up to eight days during the postoperative period.

Observations were conducted with regard to the following parameters: vital signs, clinical symptoms related to the cardiovascular, central nervous and respiratory systems, nausea, vomiting, independent ambulation, assisted ambulation, ABG analysis, wound complications, peripheral oedema, urine output and changes in various biochemical variables, among others.

STATISITICAL ANALYSIS

All the data were analysed using SPSS version 20.0. The Chi-square test was employed to compare the differences in proportions between the two groups. To compare the differences in mean values for parametric variables across more than two groups, Analysis of Variance (ANOVA) was used. To compare the differences in mean values between two groups, the student's t-test was utilised. A p-value of <0.05 was considered significant, with the confidence level of the study set at 95%.

RESULTS

A total of 150 patients were enrolled in the study. Two patients were excluded from the study due to missing data in the Ringer's Lactate (RL) group (n=48). The demographic characteristics (age, weight, sex, ASA physical status classification and duration of surgery) were comparable among the groups (p-value >0.05) [Table/Fig-1]. The study was conducted with patients undergoing Gastrointestinal (GI) surgical procedures [Table/Fig-2].

Characteristics	RL (n=48)	HS-RL (n=50)	TS-RL (n=50)	p-value
Mean age (years)	46.8±12.9	46.2±10.1	44.5±13.8	0.638
Mean weight (kg)	52.60±8.29	54.04±7.17	52.2±8.91	0.497
Sex (M:F)	29:19	31:19	22:28	0.135
ASA status 1	38	38	40	0.877
2	10	12	10	
Mean duration of surgery (hours)	4.47±1.12	4.78±1.21	4.84±1.12	0.244

[Table/Fig-1]: Demographic and baseline characteristics of the patients.
Data expressed in mean±SD, were analysed by one-way ANOVA Test. Data expressed in number, were analysed by Chi-square test., p-value >0.05, statistically not significant

Type	RL (n=48)	HS-RL (n=50)	TS-RL (n=50)
Whipple's procedure	8	16	15
Hepaticojejunostomy	16	18	19
Lateral pancreatojejunostomy	12	10	13
Radical cholecystectomy	7	3	2
Total gastrectomy	5	3	1

[Table/Fig-2]: Type of surgery.
Data expressed in numbers

Independent ambulation was highest in the Hetastrach and Ringer's Lactate (HS-RL) group, followed by the Tetrastarch and Ringer's Lactate (TS-RL) and RL groups (p-value <0.001). Ambulation with assistance was most common in the TS-RL group, followed by the HS-RL and RL groups (p-value=0.025) [Table/Fig-3]. Most patients in all groups were administered intravenous fluids for five days or more. Only 5 (10.42%) patients in the RL group and 4 (8%) patients in the TS-RL group received intravenous fluids for less than five days (p-value=0.230) [Table/Fig-4].

Parameters	Groups	Postoperative days					
		02	03	04	05	06	08
		n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Independent ambulation	RL	3 (6.25)	23 (47.12)	19 (39.52)	1 (2.08)	0	2 (4.17)
	HS-RL	23 (46)	17 (34)	7 (14)	2 (4)	1 (2)	0
	TS-RL	16 (32)	15 (30)	13 (26)	6 (12)	0	0
	Total	42 (28.38)	55 (37.16)	39 (26.35)	9 (6.08)	1 (0.68)	2 (1.35)
p-value	χ^2=33.014 (df = 10); p<0.001						
Ambulation with assistance	RL	16 (33.33)	27 (56.25)	2 (4.17)	0	0	3 (6.25)
	HS-RL	23 (46)	11 (22)	1 (2)	1 (2)	0	2 (4)
	TS-RL	24 (48)	16 (32)	4 (8)	1 (2)	1 (2)	4 (8)
	Total	75 (50.68)	54 (36.49)	7 (4.73)	2 (1.35)	1 (0.68)	9 (6.08)
p-value	χ^2 =20.426 (df=10); p=0.025						

[Table/Fig-3]: Ambulation (independent and assisted).
Test - χ^2 p-value < 0.05 statistically significant

Parameters	Groups	Postoperative days					
		02	03	04	05	06	08
		n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
i.v. fluid	RL	1 (2.08)	4 (4.33)	10 (20.83)	14 (29.17)	12 (25)	7 (14.58)
	HS-RL	0	0	10 (20)	17 (34)	12 (24)	11 (22)
	TS-RL	0	4 (8)	12 (24)	14 (28)	5 (10)	15 (30)
	Total	1 (0.68)	8 (5.4)	32 (21.62)	45 (30)	29 (19.59)	33 (22.3)
p-value	χ^2=12.881 (df=10); p=0.230						

[Table/Fig-4]: Administration of intravenous fluid over postoperative days.
Test - χ^2 p-value >0.05 statistically significant.

The means of pH, anion gap and P/F ratio among the groups were comparable (p-value >0.05), while base excess was significant (p-value <0.05) [Table/Fig-5]. No incidents of Myocardial Infarction (MI), angina, pulmonary complications, focal deficits, confusion, or coma were reported in any of the groups. Other complications reported included hypertension, hypotension, a respiratory rate greater than 20 per minute, chest infection and the requirement for respiratory support [Table/Fig-6].

Complications	Groups			Total	p-value
	RL	HS-RL	TS-RL		
	n (%)	n (%)	n (%)	n (%)	-
MI	0	0	0	0	-
Angina	0	0	0	0	-
Pulmonary oedema	0	0	0	0	-
Hypertension	0	0	4 (8)	4 (2.7)	0.018
Hypotension	6 (12.5)	2 (4)	4 (8)	12 (8.11)	0.305
Respiratory rate>20	7 (4.73)	3 (6)	12 (24)	22 (14.86)	0.041
Chest infection	0	0 (0)	1 (2)	1 (0.68)	0.373
Respiratory support	2 (4.17)	1 (2)	4 (8)	7 (4.73)	0.359
Focal defecit	0	0	0	0	-
Confussion	0	0	0	0	-
Coma	0	0	0	0	-
Temperature	24 (50)	15 (30)	22 (44)	61 (41.22)	0.117
Wound complication	0	0	2 (4)	2 (1.35)	0.137
Peripheral oedema	20 (41.67)	14 (28)	20 (40)	54 (36.49)	0.305
Double vision	0	0	0	0	-
Oliguria	1 (2.08)	6 (12)	4 (8)	11 (7.43)	0.171

[Table/Fig-6]: Overview of adverse events and complications.
Data expressed in number (%) were analysed by Chi-square test

During the intergroup comparison, no statistically significant differences were found between the groups regarding the use of intravenous fluids, mean pH, need for parenteral feed, episodes of vomiting, use of antiemetics, hypotension, chest infection, respiratory support, wound complications, peripheral oedema and oliguria [Table/Fig-7]. The mean data were analysed using the odds ratio of crystalloids (RL) versus colloids (HS-RL+TS-RL), with the RL group serving as the reference. Odds ratios were calculated for the colloids group across various outcomes, including independent ambulation, ambulation with assistance, arterial blood gas, intravenous fluid requirement, need for parenteral feeds, nausea, vomiting, complications and temperature, all with 95% confidence intervals. A statistically significant difference was observed for nausea, as the confidence interval did not cross zero [Table/Fig-8].

DISCUSSION

1. Demographic Characteristics and Baseline Comparability

The demographic parameters, including age, weight, sex, ASA classification and duration of surgery, were statistically comparable across all groups (p-value >0.05). Myles PS et al., in the RELIEF trial found that overly restrictive fluid therapy increased the risk of

Parameters	Groups									Total		p-value
	RL			HR-RL			TS-RL					
	Mean±SD	n	%	Mean±SD	n	%	Mean±SD	n	%	n	%	
Mean pH	7.397±0.051	-	-	7.380±0.044	-	-	7.387±0.041	-	-	-	-	0.187
Mean base excess	5.044±3.783	-	-	-7.618±6.328	-	-	-4.788±2.854	-	-	-	-	0.004
Mean anion gap	16.971±3.699	-	-	18.306±1.797	-	-	16.974±4.414	-	-	-	-	0.092
Mean PF ratio	507.167±105.937	-	-	547.800±81.609	-	-	527.700±95.585	-	-	-	-	0.109
Need of parenteral feed	-	0	0	-	1	2	-	1	2	2	1.35	0.615
Nausea	-	24	50	-	10	20	-	13	26	47	33.76	0.003
Vomiting	-	11	22.92	-	8	16	-	5	10	24	16.22	0.222
Use of rescue antiemetic	-	7	14.58	-	6	12	-	4	8	17	11.49	0.588

[Table/Fig-5]: Mean various parameters recorded in all groups.
Data expressed in mean±SD, were analysed by one-way ANOVA Test. Data expressed in number, were analysed by Chi-square test, arterial blood was used for ABG Analysis and both O_2 and CO_2 gases from arterial blood were used

S. No.	Variables	RL vs HS-RL		RL vs TS-RL		HS-RL vs TS-RL	
		$\chi^{2/t}$	'p'	$\chi^{2/t}$	'p'	$\chi^{2/t}$	'p'
(a)	Independent ambulation	25.126	<0.001	17.242	0.002	6.181	0.186
(b)	Ambulation with assistance	15.314	0.004	7.186	0.207	6.443	0.265
(c)	Mean pH	1.752	0.083	1.064	0.290	-0.814	0.418
	Mean base excess	2.432	0.017	0.379	0.706	2.883	0.005
	Mean anion gap	-2.287	0.024	0.004	0.997	1.976	0.051
	Mean PF ratio	-2.132	0.036	1.008	0.316	1.131	0.261
(d)	Intravenous fluid	6.141	0.293	6.935	0.225	7.970	0.093
(e)	Need of parenteral feed	0.970	0.325	0.970	0.325	0	1
	Nausea	9.728	0.002	6.002	0.014	0.508	0.476
	Vomiting	0.750	0.387	2.991	0.084	0.796	0.372
	Use of rescue antiemetic	0.142	0.706	1.065	0.302	0.444	0.505
(f)	MI	-	-	-	-	-	-
	Angina	-	-	-	-	-	-
	Pulmonary oedema	-	-	-	-	-	-
	Hypertension	-	-	4.003	0.045	4.167	0.041
	Hypotension	2.360	0.124	0.541	0.462	0.709	0.400
	Respiratory rate >20/min	1.969	0.161	1.389	0.238	6.353	0.012
	Chest infection	-	-	0.970	0.325	1.010	0.315
	Respiratory support	0.387	0.534	0.626	0.429	1.895	0.169
	Focal deficit	-	-	-	-	-	-
	Confusion	-	-	-	-	-	-
	Coma	-	-	-	-	-	-
(g)	Temperature	4.089	0.043	0.354	0.552	2.102	0.147
	Wound complication	-	-	1.960	0.162	2.041	0.154
	Peripheral oedema	2.019	0.155	0.028	0.867	1.604	0.205
	Double vision	-	-	-	-	-	-
	Oliguria	3.631	0.057	1.771	0.183	0.444	0.505

[Table/Fig-7]: Comparison of variables across groups.
Tukey HSD Posthoc test

S. No.	Variables	Odds ratio	95% CL
(a)	Independent ambulation within 3 PO days	0.482	-1.442; -0.015
(b)	Ambulation with assistance within 2 PO days	0.347	-1.778; -0.337
(c)	Mean pH		-0.002; 0.029
	Mean base excess		-0.474; 2.792
	Mean anion gap		-1.888; 0.549
	Mean PF ratio		-63.476; 2.309
(d)	Intravenous fluid<5 days	2.791	-0.336; 2.389
(e)	Need of parenteral feed	-	-
	Nausea	3.348	0.475; 1.941
	Vomiting	1.989	-0.202; 1.578
	Use of rescue antiemetic	0.682	-1.321; 0.558
(f)	MI	-	-
	Angina	-	-
	Pulmonary oedema	-	-
	Hypertension	-	-
	Hypotension	2.238	-0.838; 1.994
	Respiratory rate>20/min	0.967	-1.004; 0.938
	Chest infection	-	-
	Respiratory support	0.826	-1.868; 1.486
	Focal deficit	-	-
	Confusion	-	-
	Coma	-	-
(g)	Temperature	1.703	-0.164; 1.228
	Wound complication	-	-
	Peripheral oedema	1.387	-0.381; 1.034
	Double vision	-	-
	Oliguria	0.199	-3.739; 0.433

[Table/Fig-8]: Odds ratios (95% confidence limits) for all variables. {Crystalloids (RL) v/s Colloids (HS-RL+TS-RL)}
Posthoc test, The mean data was analysed using the odds ratio of Crystalloids (RL) versus Colloids (HS-RL + TS-RL), with the RL group serving as the reference, A statistically significant difference was observed for nausea, as the confidence interval did not cross zero

kidney injury without improving recovery [16]. This supports the finding that balanced strategies (e.g., HS-RL group) led to better postoperative ambulation. Bundgaard-Nielsen M et al., highlighted the risks of both fluid overload and deficit, reinforcing the conclusion that individualised fluid management improves functional recovery, as evidenced by ambulation outcomes [17].

2. Functional Recovery and Ambulation

Patients in the HS-RL group demonstrated significantly better functional recovery, with more patients ambulating independently or with assistance than in the TS-RL and RL groups (p-value <0.05). Myles PS et al., showed that restrictive fluid therapy increased the risk of kidney injury without improving outcomes, which could potentially delay recovery [16]. Similarly, the present study found that balanced fluid strategies (e.g., HS-RL) promoted earlier ambulation and enhanced functional recovery. Kehlet H and Wilmore DW emphasised early mobilisation as central to enhanced recovery protocols [18]. This supports the present study finding that appropriate intraoperative fluid management aids quicker ambulation and overall recovery within Enhanced Recovery Protocols (ERPs).

3. Duration of Intravenous Fluid Therapy

Across all groups, most patients required intravenous fluids for five or more days, with no significant difference among the groups (p-value=0.230). This suggests that the fluid regimen may not influence the duration of fluid therapy but may still affect the quality of recovery. Bundgaard-Nielsen M et al., concluded that neither liberal nor restrictive fluid strategies are ideal, advocating instead for goal-directed, individualised therapy [17]. This aligns with the present study findings, where a balanced approach (e.g., HS-RL) led to shorter, more efficient fluid use and improved recovery. Walsh SR et al., found that prolonged or inconsistent fluid therapy delays recovery [19]. Similarly, the present results suggest that structured, goal-directed fluid management optimises therapy duration and supports faster postoperative outcomes.

4. Biochemical Parameters

The findings were consistent with previously published evidence. Myles PS et al., emphasised the impact of fluid strategy on organ function, while Young P et al., showed that balanced crystalloids reduce the risk of acute kidney injury compared to saline [16,20]. In the present study, the mean values of pH, anion gap and P/F ratio were comparable across groups (p-value >0.05). However, base excess showed a statistically significant difference (p-value <0.05),

indicating a possible variation in acid-base status related to the type of fluid administered.

5. Postoperative Complications

Myles PS et al., (RELIEF trial) reported no major differences in adverse events between fluid strategies but noted higher renal complications associated with restrictive therapy [16]. Similarly, the present study found no major adverse events and comparable minor complications across the groups, supporting the safety of balanced fluids. Semler MW et al., demonstrated that balanced crystalloids reduced kidney injury and complications compared to saline [21]. The present study findings align with this, showing low complication rates and supporting the safer profile of balanced solutions like HS-RL.

6. Other Clinical Outcomes

No significant differences were observed among the groups in terms of the requirement for parenteral feeds, nausea, vomiting, use of antiemetics, wound complications, peripheral oedema, or oliguria. These findings suggest that while HS-RL may improve early ambulation, other recovery metrics remain similar across fluid strategies. This is consistent with prior research indicating that these outcomes are influenced by broader perioperative management strategies rather than fluid choice alone [17,19].

Limitation(s)

The cases included in the study were of mild to moderate surgical severity; therefore, the effect of the two fluids on severe complications, including death, could not be commented upon. As this was a randomised prospective study completed within a prescribed time limit, it is necessary to conduct a larger study spanning a longer period, with the capacity to include patients of all severity types.

CONCLUSION(S)

The key message of the present study was that HS-RL may offer advantages in early functional recovery, particularly in terms of independent ambulation and mobility, when compared to other crystalloid formulations such as TS-RL and standard Ringer's Lactate (RL). While the duration of intravenous fluid administration and various biochemical markers, including pH, anion gap and P/F ratio, were similar across groups, base excess differed significantly (p-value <0.05), suggesting that fluid type may affect acid-base balance. HS-RL demonstrated improved functional outcomes without increasing adverse events. The study suggests that, while colloids may offer certain benefits, balanced crystalloids, especially HS-RL, can provide comparable or superior recovery metrics in postoperative patients. Furthermore, the use of balanced crystalloids was safe, with no major complications, such as myocardial infarction, pulmonary events, or neurological deficits reported. This highlights the potential of HS-RL as a promising fluid choice for enhancing early recovery following surgery.

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