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Does perioperative fluid management affect the development of postoperative complications in major gastrointestinal tract surgery? A retrospective cohort study

Mehmet Mustafa Altintas [1], Kemal Tolga Saraçoğlu [2], Aytac Emre Kocaoglu [1], Fırat Mülküt [1], Ayten Saraçoğlu [3], Selçuk Kaya [1], Ayhan Çevik [1]

[1] Istanbul Kartal Dr. Lutfi Kirdar City Hospital, Department of General Surgery, Istanbul, Turkey
[2] Istanbul Kartal Dr. Lutfi Kirdar City Hospital, Department of Anesthesiology and Reanimation, Istanbul, Turkey
[3] Marmara University Pendik Teaching Hospital, Department of Anesthesiology and Reanimation, Istanbul, Turkey

ORCID ID of the author(s)

MMA: 0000-0002-1522-8687
KTS: 0000-0001-9470-7418
AEK: 0000-0003-1099-0020
FM: 0000-0003-4049-7595
AS: 0000-0002-1186-0933
SK: 0000-0001-5729-9742

Corresponding Author
Mehmet Mustafa Altintas
Istanbul Kartal Dr. Lutfi Kirdar City Hospital, Department of General Surgery, Istanbul, Turkey
E-mail: mehmetal1@hotmail.com

Ethics Committee Approval
The study was approved by the local Ethics Committee of Istanbul Kartal Dr. Lutfi Kirdar City Hospital (514/194/30-27.01.2021)
All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

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No conflict of interest was declared by the authors.

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Abstract

Background/Aim: In major abdominal surgeries, maintenance of electrolyte homeostasis and euvolemia is crucial. However there is still no consensus on the most effective intraoperative fluid regimen. Our primary aim in this study was to investigate the impact of colloid infusion given in addition to perioperative fluid replacement on the development of postoperative complications in patients undergoing major gastrointestinal tract surgery.

Methods: Patients who underwent major abdominal surgery in our hospital due to gastrointestinal tract malignancy between January 2015 and January 2020 were enrolled in this retrospective cohort study. We recorded data regarding the volume of perioperative fluid replacement, the amount of crystalloid and colloid administered, postoperative complications, length of hospital stay, frequency of follow-up in the intensive care unit and length of stay.

Results: A total of 326 patients, who underwent gastrointestinal tract surgery, were included in the study. Postoperative pulmonary complications (24.2%), wound infection (20.6%), and anastomotic leakage (3.1%) were the most-observed three complications in the study cohort. Among 163 patients who required postoperative ICU follow-up, 84 (25.7%) patients received colloid infusion, whereas 79 (24.2%) patients did not receive (P=0.181). However, the incidence of other complications in the group with a crystalloid intake of ≤2 L was found to be significantly higher compared to the group receiving >2 L of crystalloids (P=0.038).

Conclusion: We found no association between the administration of colloids along with crystalloid infusion and the incidence of postoperative complications. Besides there was no relation with the adverse effects in terms of the length of hospital stay and the frequency of admission to the intensive care unit.

Keywords: Crystalloid, Colloid, Surgery, Fluid replacement

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Introduction

Perioperative fluid management in major surgeries aims to optimize intravascular fluid balance to maintain adequate tissue perfusion. Fluids administered with this purpose directly impacts patient outcome [1]. Both the volume of fluids administered and the decision of using colloids or crystalloids have been topics of discussion for years [2]. Colloid fluids provide the continuity of oncotic pressure, providing a decrease in the total amount of perioperative fluid required [3]. Hydroxyethyl starch (HES) and gelatin solutions are the two colloid fluids easily accessible and most commonly used. These fluids are used for volume replacement in hemorrhagic surgeries to compensate the period up to blood transfusion. Modern starches are considered safe for use in surgery [4]. However, the use of colloids is not complication-free. Serious side effects such as acute kidney injury, bleeding, and death are reported following the use of HES [5, 6]. Similarly, gelatins are reported to have adverse effects on renal functions and coagulation parameters [7, 8].

In major abdominal surgeries, the goal is to maintain electrolyte homeostasis while attempting to achieve euvolemia. In the majority of surgeries, intraoperative bleeding and third space losses accompany the condition of hypovolemia [9]. As a result of increased microvascular permeability, capillary leaks and hemostatic disorders can develop [10]. There is still no consensus on the most effective intraoperative fluid regimen [11].

Our primary aim in this study was to investigate the impact of colloid fluid infusion given in perioperative fluid replacement on the development of postoperative complications in patients undergoing major gastrointestinal tract surgery. Our secondary aim was to investigate the effect of colloid use on the incidence of intensive care unit admission and the length of hospital stay.

Materials and methods

Following the approval of the local Ethics Committee (514/194/30-27.01.2021), patients who underwent major abdominal surgery at our hospital due to gastrointestinal tract malignancy between January 2015 and January 2020 were enrolled in this retrospective study. Data regarding the volume of perioperative fluid replacement, the amount of crystalloid and colloid fluids administered, postoperative complications, length of hospital stay, frequency of admission to the intensive care unit are recorded.

All patients were given 10 -12 mL/kg/h intravenous (IV) crystalloid infusion in the perioperative period to meet their requirements [12]. The central venous pressure was monitored with a 7F catheter. Patients with CVP <8 mmHg and/or a 20% change in hemodynamics compared to baseline values were determined to have a fluid deficit and colloid fluid replacement is started [12]. HES and gelatin were used as colloid fluids, whereas Ringer's lactate and 0.9% saline were the crystalloid solutions used. Patients were given colloid infusion in addition to crystalloids until blood and blood products became available for replacement. Patients who required crystalloid fluid more or less than 2 L were recorded. In patients who received a high volume of crystalloid and/or colloid fluid replacement, the association of fluid replacement with postoperative complications, frequency of ICU admission, and length of hospital stay was examined.

Patients with incomplete data, and patients who required vasopressors in the intraoperative period were excluded from the study.

Statistical analysis

We used descriptive statistics of mean, standard deviation, median, minimum, maximum, frequency, and ratio. The Kolmogorov Smirnov test was used to measure the distribution of the variables. Quantitative independent data were analyzed by Mann-Whitney U test. Quantitative independent data were analyzed by the Chi-square test, but when the conditions for the Chi-square test were not met, Fisher test is used. SPSS 27.0 program was used for the analyses.

Results

For five years, a total of 18,986 patient files were scanned who underwent operations in general surgery. Of those, 585 patients which had gastrointestinal tract surgery were enrolled in the study. However, 259 patients were excluded from the study because of missing data. We analyzed the data of 326 patients in total. The mean age of patients was 61.3 (46-74) years. The most commonly performed gastrointestinal surgical procedures were total gastrectomy (25.2%), low anterior resection (LAR) (24.8%), and anterior resection (14.4%). The mean length of hospital stay was 7.5 (5-14) days. On average, 2572.4 (750-4500) mL crystalloids were used. Colloid fluids were administered to 55.2% of the patients. The average of colloid fluids used was 727.8 (300-1200) mL (Table 1).

Table 1: Comparison of patients in terms of demographic characteristics, surgical details, amount of crystalloid and colloid given, and length of hospital stay

		Mean (SD) /n-%	
Age (year)		61.3	(46-74)
Gender	Female	197	60.4%
	Male	129	39.6%
Tumor size (cm)		49.1	(29.6)
Number of positive lymph nodes		3.6	(7.0)
Hb (g/dL)		11.6	(2.3)
Received colloids	No	146	44.8%
	Yes	180	55.2%
Amount of colloids (mL)		727.8	(300-1200)
Amount of crystalloids (ml)	>2000	192	58.9%
	<2000	134	41.1%
Total amount of crystalloids (mL)		2572.4	(750-4500)
Surgical procedure	Anterior resection	47	14.4%
	LAR	81	24.8%
	Miles	6	1.8%
	Right hemicolectomy	41	12.6%
	Segmental resection	1	0.3%
	Sleeve gastrectomy	6	1.8%
	Left hemicolectomy	12	3.7%
	Subtotal gastrectomy	45	13.8%
	Subtotal esophagectomy	4	1.2%
	Total gastrectomy	82	25.2%
	Total colectomy	1	0.3%
Postoperative admission to ICU	(-)	163	50.0%
	(+)	163	50.0%
Length of hospital stay (days)		7.5	(5-14)
Discharge status	Transferred to another hospital with the same scope of practice	3	0.9%
	Transferred to another hospital with broader scope of practice	2	0.6%
	Transferred to another department within the same hospital	73	22.4%
	Discharged in stable condition	156	47.9%
	Discharged with healing	88	27.0%
	Exitus	4	1.2%

Postoperative pulmonary complications (24.2%), wound infection (20.6%), and anastomotic leakage (3.1%) were the mostly observed three complications in our patient population. Postoperative pulmonary complications include atelectasis, laryngospasm, bronchospasm, pulmonary embolism, and pneumothorax. Pulmonary embolism developed in one patient (14.3%) who did not receive colloids, and pneumothorax developed in one patient (14.3%) who received colloids. The distribution of complications did not significantly differ between the groups with and without colloid infusion. Postoperative pulmonary complications were observed in 46 (14.1%) patients who were given colloid fluid and in 33 (10.1%) patients who did not receive colloids (P=0.536).

Even though 84 (25.7%) patients who received colloid infusion required postoperative ICU follow-up, 79 (24.2%) patients without any colloids given were admitted to ICU (P=0.181). There was no significant difference between these two groups in terms of patients' discharge status and length of hospital stay (P>0.05 and P=0.971, respectively) (Table 2).

Table 2: Comparison of patients that received colloid and that did not receive, in terms of postoperative complications, ICU admission rates, length of hospital stay, and discharge status.

	Received colloids (-) Mean (SD)/n-%		Received colloids (+) Mean (SD)/n-%		*P*-value	
Complications						
Postoperative pulmonary complication	33	22.6%	46	25.6%	0.536	X^2
Wound site infection	31	21.2%	36	20.0%	0.784	X^2
Anastomotic leakage	3	2.1%	7	3.9%	0.340	X^2
Other complications	7	4.8%	11	6.1%	0.605	X^2
Hemorrhagic drainage	2	28.6%	2	18.2%		
Ureteral injury	0	0.0%	2	18.2%		
Subcutaneous hematoma	1	14.3%	0	0.0%		
Evisceration	0	0.0%	1	9.1%		
Ischemic hepatitis	1	14.3%	0	0.0%		
Delayed oral intake tolerance	1	14.3%	0	0.0%		
Stricture at the opening of the stoma	0	0.0%	1	9.1%		
Stoma retraction	1	14.3%	0	0.0%		
Stoma retraction, fasciitis	0	0.0%	1	9.1%		
Stomal ischemia	0	0.0%	1	9.1%		
Repair of ureter and bladder	0	0.0%	1	9.1%		
Vocal cord edema	0	0.0%	1	9.1%		
Postoperative ICU (-)	67	45.9%	96	53.3%	0.181	X^2
(+)	79	54.1%	84	46.7%		
Number of inpatient days	7.4	(7.1)	7.5	(5.3)	0.329	m
Discharge status						
Transferred to another hospital	2	1.4%	3	1.7%	1.000	X^2
Transferred to another department within the same hospital	27	18.5%	46	25.6%	0.128	X^2
Discharged in stable condition	74	50.7%	82	45.6%	0.357	X^2
Discharged with healing	42	28.8%	46	25.6%	0.516	X^2
Exitus	1	0.7%	3	1.7%	0.631	X^2

m: Mann-Whitney u test, X^2: Chi-square test (Fischer test)

The rates of postoperative pulmonary complications, wound infection and anastomotic leakage did not differ significantly between patients with a crystalloid infusion of ≤2 L or >2 L (P>0.05). However, the incidence of other types of complications in the group with a crystalloid infusion of ≤2 L was found to be significantly higher compared to the group receiving >2 L of crystalloids (P=0.038). Nevertheless, there was no significant difference between the amount of crystalloid infusion and the rate of admission to ICU in the postoperative period, the length of hospital stay, and patients' discharge status (P>0.05, Table 3).

Table 3: Comparison of patients that received more than 2 L crystalloid solution and those that received less than 2 L, in terms of postoperative complications, ICU admission rates, length of hospital stay, and discharge status.

	Crystalloid ≤2000 Mean (SD) /n-%		Crystalloid >2000 Mean (SD)/n-%		*P*-value	
Complications						
Postoperative pulmonary complication	44	22.9%	27	24.1%	0.813	X^2
Wound site infection	36	18.8%	25	22.3%	0.453	X^2
Anastomotic leakage	6	3.1%	2	1.8%	0.482	X^2
Other complications	14	7.3%	2	1.8%	0.038	X^2
Hemorrhagic drainage	3	21.4%	0	0.0%		
Ureteral injury	2	14.3%	0	0.0%		
Subcutaneous hematoma	1	7.1%	0	0.0%		
Evisceration	1	7.1%	0	0.0%		
Ischemic hepatitis	1	7.1%	0	0.0%		
Delayed oral intake tolerance	1	7.1%	0	0.0%		
Stricture at the opening of the stoma	0	0.0%	1	50.0%		
Stoma retraction	1	7.1%	0	0.0%		
Stoma retraction, fasciitis	0	0.0%	1	50.0%		
Stomal ischemia	1	7.1%	0	0.0%		
Repair of ureter and bladder	1	7.1%	0	0.0%		
Need for postoperative admission (-)	94	49.0%	55	49.1%	0.980	X^2
to ICU (+)	98	51.0%	57	50.9%		
Number of inpatient days	7.2	(5.0)	7.9	(7.8)	0.971	m
Discharge status						
Transferred to another hospital	2	1.0%	1	0.9%	1.000	X^2
Transferred to another department within the same hospital	40	20.8%	25	22.3%	0.760	X^2
Discharged in stable condition	97	50.5%	54	48.2%	0.698	X^2
Discharged with healing	50	26.0%	32	28.6%	0.632	X^2
Exitus	3	1.6%	0	0.0%	0.300	X^2

m: Mann-Whitney u test, X^2: Chi-square test (Fischer test)

Discussion

This retrospective study investigated patients who underwent major abdominal surgery due to gastrointestinal system malignancy. It was demonstrated that the risk of developing complications did not increase in patients when the volume of crystalloid fluid replacement was increased or colloid fluid infusion was added in the intraoperative period. There was no significant difference in the need for postoperative intensive care or the length of hospital stay in patients receiving colloids.

There is still controversy on the intraoperative fluid regimen and the types and amount of fluids used. Conflicting results have been reported in studies addressing this matter. In a study evaluating the adequacy of tissue perfusion through measurement of subcutaneous oxygen tension, the fluid requirements of patients undergoing elective open abdominal surgery were met with boluses of Ringer's lactate or HES [13]. Postoperative surgical site infection or subcutaneous partial oxygen pressure did not differ significantly in the colloid-administered group. In this study, Ringer's lactate and 0.9% saline solution was compared with colloids. Apart from HES, the effectiveness of gelatins was also evaluated and it was revealed that colloids added to crystalloids did not have a significant negative effect on patient outcomes.

In abdominal surgeries, the amount of fluid administered in the perioperative period may vary in different operations and hospitals. In one study, the total amount of crystalloid fluid given in abdominal surgeries was calculated [14]. It was demonstrated that the amount highly differ depending on the anesthesiologists. The total amount of crystalloids infused to provide 1 mL/kg/h urine output in a 4-hour surgery has been reported to vary from 700 to 5400 mL. On the other hand, Kim et al. [15] reported that 90% of the differences in the amount of fluid administered are due to factors related to the patients, emphasizing that the role of care providers in this difference is as low as 10%. Many factors including the size of the surgical incision, patients' oncotic pressure, third

space losses, and the amount of hemorrhage can affect this. Besides the effects of colloids, the results of the amount of crystalloids given to the patients were also investigated in this study, and the cut-off value was determined as 2 L. Nevertheless, there was no significant increase in the incidence of postoperative complications in patients given cristalloid infusions below or above this value. The three most common complications observed were postoperative pulmonary complications, wound site infection, and anastomotic leakage, respectively. Moreover, the rate of complications developing other than these was found to be higher in patients who had fluid infusion less than 2 L which shows the importance of achieving euvolemia and applying an optimal fluid regimen for patients.

Also, the necessity of avoiding colloidal overload is clear. As with all replacement fluids, some complications have been reported during the use of colloid fluids. A study including 1041 patients revealed that postoperative delirium developed in 22.7% of patients who were given HES during esophagectomy [16]. In another study, HES and Ringer's lactate were compared regarding their effects on perioperative fibrinogen thromboelastometry (FIBTEM) and maximum clot firmness (MCF) values [17]. A dose-dependent deterioration impairment in fibrin polymerization was observed in patients who received HES. However, it was reported that the results returned to normal on the first postoperative day without the need for procoagulant agents, and there was no difference in blood loss of the patients. Colloids used for the treatment of patients in intensive care unit have been reported to have iatrogenic side effects and have been associated with acute kidney injury and mortality [18]. However, it was emphasized that damage to the endothelial glycocalyx layer of critically ill patients may also have a role in that result. In our study, the data of patients were examined in terms of complications that may develop during the hospitalization (for an average of 1 week). It was found that the use of colloids did not pose any additional risk within the specific time. Therefore, it was concluded that the use of colloids is safe unless there is an overdose in the operating rooms.

Limitations

The most significant limitation of this study is that the goal-directed hemodynamic strategy was not used in the perioperative period. Transesophageal Doppler evaluation or non-invasive monitoring of cardiac output and stroke volume were not performed to determine the patients' response to fluid therapy. The response to fluid therapy was only evaluated through CVP and hemodynamic data. Another limitation to note is the retrospective design and the sample size of the study. It is obvious that there is a need for further clinical trials with larger series of patients to decrease the controversies on this subject.

Conclusion

In patients undergoing major abdominal cancer surgery, administering colloids along with the crystalloid infusion is not associated with the incidence of postoperative complications, the length of hospital stay and the frequency of admission to the intensive care unit.

References

1. Myburgh JA, Mythen MG. Resuscitationfluids. N Engl J Med. 2013;369(13):1243–51.doi: 10.1056/NEJMra1208627.
2. Joosten A, Coeckelenbergh S, Alexander B, Delaporte A, Cannesson M, Duranteau J, et al. Hydroxyethylstarch for perioperative goal-directed fluid therapy in 2020: a narrative review. BMC Anesthesiol. 2020 Aug 20;20(1):209. doi: 10.1186/s12871-020-01128-1.
3. Joosten A, Delaporte A, Ickx B, Touihri K, Stany I, Barvais L, et al. Crystalloidversuscolloidforintraoperativegoal-directedfluidtherapy using a closed-loop system: arandomized, double-blinded, controlled trial in major abdominal surgery.Anesthesiology. 2018;128(1):55-66.doi: 10.1097/ALN.0000000000001936.
4. Van Der Linden P, James M, Mythen M, Weiskopf RB. Safety of modern starches used during surgery. Anesth Analg. 2013;116(1):35-48.doi: 10.1213/ANE.0b013e31827175da.
5. Johansen JR, Perner A, Brodtkorb JH, Møller MH. Use of hydroxyethyl starch in sepsis research: A systematic review with meta-analysis. Acta Anaesthesiol Scand. 2021;65(10):1355-64.doi: 10.1111/aas.13954.
6. Nagore D, Candela A, Bürge M, Monedero P, Tamayo E, Alvarez J, et al; Spanish Perioperative Cardiac Surgery Research Group. Hydroxyethylstarchandacutekidneyinjury in high-risk patients undergoing cardiacsurgery: A prospective multicenter study. J Clin Anesth. 2021;73:110367. doi: 10.1016/j.jclinane.2021.110367.
7. Heringlake M, Berggreen AE, Reemts E, Schemke S, Balzer F, Charitos EI, et al. Fluid Therapy With Gelatin May Have Deleterious Effects on Kidney Function: An Observational Trial. J Cardiothorac Vasc Anesth. 2020;34(10):2674-81. doi: 10.1053/j.jvca.2020.03.037.
8. Sevcikova S, Durila M, Vymazal T. Rotational thromboelastometry assessment of balanced crystalloid, hydroxyethyl starch and gelatin effects on coagulation: a randomized trial. Braz J Anesthesiol. 2019;69(4):383-9. Portuguese. doi: 10.1016/j.bjan.2019.03.009.
9. Myles PS, Bellomo R, Corcoran T, Forbes A, Peyton P, Story D, et al. Australian and New Zealand College of Anaesthetists Clinical Trials Network and the Australian and New Zealand Intensive Care Society Clinical Trials Group. Restrictive versus Liberal Fluid Therapy for Major Abdominal Surgery. N Engl J Med. 2018;378(24):2263-74. doi: 10.1056/NEJMoa1801601.
10. Saracoglu KT, Eti Z, Ugurlu U, Orhon M, Gogus FY. The effects of preoperative fluid administration on postoperative acid-base and electrolyte balance in patients undergoing total gastrectomy. Anestezi Derg. 2014;22(1):18-24.
11. Myles P, Bellomo R, Corcoran T, Forbes A, Wallace S, Peyton P, et al. Australian and New Zealand College of Anaesthetists Clinical Trials Network, and the Australian and New Zealand Intensive Care Society Clinical Trials Group. Restrictive versus liberal fluid therapy in major abdominal surgery (RELIEF): rationale and design for a multi centre randomized trial. BMJ Open. 2017;7(3):e015358. doi: 10.1136/bmjopen-2016-015358.
12. Miller TE, Myles PS. Perioperative Fluid Therapy for Major Surgery. Anesthesiology. 2019;130(5):825-32. doi: 10.1097/ALN.0000000000002603.
13. Reiterer C, Kabon B, Zotti O, Obradovic M, Kurz A, Fleischmann E. Effect of goal-directed crystalloid- versus colloid-based fluid strategy on tissue oxygen tension: a randomized controlled trial. Br J Anaesth. 2019;123(6):768-76. doi: 10.1016/j.bja.2019.08.027.
14. Lilot M, Ehrenfeld JM, Lee C, Harrington B, Cannesson M, Rinehart J. Variability in practice and factors predictive of total crystalloid administration during abdominal surgery: retrospective two-centre analysis. Br J Anaesth. 2015;114(5):767-76. doi: 10.1093/bja/aeu452.
15. Kim Y, Gani F, Spolverato G, Ejaz A, Xu L, Buettner S, et al. Variation in crystalloid administration: an analysis of 6248 patients undergoing major elective surgery. J SurgRes. 2016;203(2):368-77. doi: 10.1016/j.jss.2016.02.045.
16. Jung DM, Ahn HJ, Yang M, Kim JA, Kim DK, Lee SM, et al. Hydroxyethyl starch is associated with early postoperative delirium in patients undergoing esophagectomy. J Thorac Cardiovasc Surg. 2018;155(3):1333-43. doi: 10.1016/j.jtcvs.2017.10.077.
17. Gratz J, Zotti O, Pausch A, Wiegele M, Fleischmann E, Gruenberger T, et al. Effect of Goal-Directed Crystalloid versus Colloid Administration on Perioperative Hemostasis in Partial Hepatectomy: A Randomized, Controlled Trial. J ClinMed. 2021;10(8):1651. doi: 10.3390/jcm10081651.
18. Kang D, Yoo KY. Fluid management in perioperative and critically ill patients. Acute Crit Care. 2019;34(4):235-45. doi: 10.4266/acc.2019.00717.

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