Analysis on the association of intraoperative fluid balance and short-term outcomes after radical gastrectomy in aged patients

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Research Article

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Abstract

Background

To observe the relationship between fluid balance and the short-term outcomes of aged patients after gastrectomy for gastric cancer in Nanjing Drum Tower Hospital.

Methods

The clinical data of patients with gastrectomy for gastric cancer from January 2016 to December 2018 were retrospectively analyzed. 691 patients were analyzed and classified into three fluid administration groups representing incremental quartiles of the primary exposure variable. Preoperative characteristics used for statistical adjustment included gender, age, weight, admission type, ASA degree. Operative factors included procedure duration, estimated blood loss, urine output, and so on. The primary outcomes included acute kidney injury (AKI), and postoperative respiratory complications (PRCs) Exploratory outcomes included length of stay, postoperative length of stay and total cost of hospitalization. The association between perioperative factors and AKI/PRCs in hospital was tested with multivariable logistic regression analyses.

Results

16 cases were diagnosed as AKI and 23 cases PRCs. The association between intraoperative fluid balance and the incidence of AKI/ PRCs remained U-shaped but the difference was not statistically significant. After adjustment, lower urine output ($P = 0.017$, $OR = 0.997$,95%$CI = 0.994–0.999$) and coronary heart disease ($P = 0.032$, $OR = 4.867$,95%$CI = 1.142–20.75$) were independent predictor of AKI in aged patients. Coronary heart disease ($OR = 3.371$,95%$CI = 1.021–11.129$, $P = 0.049$) and intestinal obstruction ($OR = 12.501$,95%$CI = 3.058–51.107$, $P < 0.0005$) were independent predictor of PRCs in aged patients.

Conclusions

There were no significant association between the incidence of AKI or any other complications and intraoperative fluid balance during radical gastrectomy in aged patients. Lower urine output and coronary heart disease were independent predictors of AKI. Coronary heart disease and intestinal obstruction were independent predictors of PRCs in aged patients after radical gastrectomy.

Trial registration:

This study was approved by the Affiliated Drum Tower Hospital of Nanjing University (Registration number: 2018-162-01).

Key Summary Points

Aim: To observe the relationship between fluid balance and the short-term outcomes of aged patients after gastrectomy for gastric cancer.

Findings: Lower urine output and coronary heart disease were independent predictors of AKI. Coronary heart disease and intestinal obstruction were independent predictors of PRCs in aged patients after radical gastrectomy.

Message: Gastric cancer is a relatively serious tumor of the digestive system, which mostly occurs in the elderly. Radical gastric cancer is a commonly used surgical procedure. We conducted this retrospective study to explore the optimal strategy of fluid therapy on postoperative clinical outcomes like acute renal injury (AKI), postoperative respiratory complications (PRCs) and also tried to identify the independent predictors of such complications in aged patients undergone gastric cancer radical surgery.

Background

With rapidly ageing population in the world and the progress in medical care, more elderly patients are undergoing surgery[1]. Perioperative fluid management, one of the key components of enhanced recovery pathways, has been widely used in surgical procedures. Optimal intraoperative fluid management is important because both under and over fluid balance (FB) may associated with harm[2–5]. Prior studies found that exposure to positive or negative FB was associated with long-term mortality compared with even FB[6], while another trial recently found that even FB was associated with a higher rate of acute kidney injury[7]. Therefore, the evidence for fluid therapy during and immediately after surgery is still inconclusive.

Fluid therapy should only be given in well-defined protocols according to individual needs[8, 9], especially the aged[10]. Markedly increased cases of operations in fast-elderly population have posed a significant challenge to medical health field. Elderly subjects have reduced ability of regulating homeostasis, decreased myocardial function and impaired pulmonary reserve function, and these may significantly increase susceptibility for multiple diseases after surgery. Thus, identifying an optimal strategy of fluid resuscitation for elderly patients during perioperative will improve outcomes.

Therefore, aged patients undergone gastric cancer radical surgery were chosen, a common surgical operation. We conducted this retrospective study to explore the optimal strategy of fluid therapy on postoperative clinical outcomes like acute renal injury (AKI), postoperative respiratory complications (PRCs) and so on. We also tried to identify the independent predictors of such complications.

Methods

Participants

All methods were carried out in accordance with relevant guidelines and regulations of the Affiliated Drum Tower Hospital of Nanjing University. Since it is not harmful to patients with data collected, a statement on consent waiver for this study was approved by Ethics Committee of the Affiliated Drum Tower Hospital of Nanjing University (Registration number: 2018-162-01). Subjects in this research were consecutively recruited from January 2016 to December 2018 and undergoing gastric cancer radical surgery. The inclusion criteria included: 1) age ≥ 65, 2) American Society of Anesthesiologists (ASA) ≤▯. The exclusion criteria were as follows: 1) no renal function test was performed during the perioperative period. 2) hepatic and or kidney dysfunction. 3) vital cardiovascular dysfunction 4) preoperative coagulation dysfunction 5) severe surgery within the past year 6) incomplete medical records. A total of 691 subjects were enrolled. The subjects were divided into 3 groups according to the intraoperative liquid intake (input minus output) by percentile method: low intake group (< 25%), medium intake group(26%~75%), and high intake group (> 75%). The subjects were further divided into AKI group and non-AKI group according to whether acute renal injury (AKI) developed or not. The subjects were divided into PRCs groups and non-PRCs according to whether postoperative respiratory complications (PRCs) appeared.

Anesthesia treatment

All participants received general anesthesia according to a standardized protocol. All patients received standard monitoring, heart rate, arterial pressure, central venous pressure, PETCO2, SpO2 and body temperature were recorded continuously. All aspects of clinical care were documented in each patient's medical record.

Short-term prognosis after operation

All patients were transferred to PACU or ICU after operation and experienced the process of recovery. They were transferred to the general ward when condition stable. The time of defecation was recorded to judge the recovery of intestinal function. Urine volume and serum creatinine were recorded to judge whether acute renal injury (AKI) developed or not after surgery[11]. In this study, PRCs were recorded with the definition of pneumonia or pulmonary edema with imaging evidence, respiratory failure, and / or intubation within 3 days after surgery.

Statistical analysis

The measurement data which presented as the mean ± SD or Median (Quartiles) were statistically analyzed with One-way ANOVA, Kruakal Wallis rank sum test or t test. The numeration data were statistically analyzed with Fisher test or χ^2 test. All statistics were performed with SPSS v24.0, Empowerstats software and R software. $P < 0.05$ was considered to be statistically significant.

Results

1 Prediction of AKI occurrence

In this study, 16 patients fulfilled the diagnostic criteria for AKI. The incidence rate of AKI was 2.32% (16/691) during hospitalization. The patients of AKI group were older (74.5 vs 71.85, P = 0.036), with higher anemia and coronary disease incidence (62.5% vs 36.89%, P = 0.036; 18.75% vs 4.15%, P = 0.031) and lower albumin level preoperative (36.54 vs 38.32, P = 0.028). The use of Dizosin was lower in AKI group when compared with non-AKI group intraoperative (43.75% vs 69.19%, P = 0.03). The AKI group has a higher in-hospital mortality (6.25% vs 0.3%, P = 0.068), postoperative length of stay (16 vs 11, P < 0.001), total length of stay (26 vs 18, P < 0.001) and total cost of hospitalization (131737.29 vs 75083.1, P < 0.001). (Fig. 1).

After adjusting for confounding variables (age, albumin level preoperative anemia, use of Dizosin and liquid balance), Preoperative coronary disease (OR 4.867, 95% CI: 1.142–20.750, P = 0.032) and decreased urine output (OR 0.997, 95% CI: 0.994–0.999, P = 0.017) were respectively independent risk factors for the incidence of AKI in elderly patients after radical gastrectomy (Fig. 2). After put the intraoperative net fluid intake and intraoperative fluid balance group as exposure variables and adjusted for confounding variables like age, albumin level preoperative, preoperative coronary disease and so on, no correlation has been found between the net fluid input and the incidence of AKI in elderly patients after radical gastrectomy (Fig. 3).

2 Prediction of PRCs occurrence

Among these 691 patients, PRCs was detected in 23 (3.33%) during hospitalization. Compared with non-PRCs group, PRCs patients have an older age (74.48 vs 71.82, P = 0.01), increased hypertension (65.22% vs 44.10%, P = 0.044), coronary disease (17.39% vs 4.05%, P = 0.016) and digestive tract obstruction incidence (13.04% vs 1.95%, P = 0.014). The intraoperative urine volume of PRCs group was lower than that of non PRCs group (300 vs 500, P = 0.03). The postoperative hospitalization time and total hospitalization time were significantly longer (15.43 vs 12.95, P = 0.003; 22.7 vs 19.07). The total cost of hospitalization increased markedly (94333.17 vs 75779.37, P < 0.001). (Fig. 4)

After adjusting for confounding variables (age, hypertension and so on), the logistic regression analysis identified that the occurrence of coronary disease (OR 3.371, 95% CI: 1.021–11.129, P = 0.049) and digestive tract obstruction before surgery (OR 12.501, 95% CI: 3.058–51.107, P < 0.0005) remained independent predictors of the incidence of PRCs in elderly patients after radical gastrectomy. (Fig. 5A). Put the intraoperative net liquid intake and intraoperative fluid balance group as exposure variables and adjusted for confounding variables like age, hypertension, preoperative coronary disease and so on, no links has been shown between the net fluid input and the incidence of PRCs in elderly patients after radical gastrectomy (Fig. 5B).

3 Prediction of defecating time

The average defecation time was 5.79 ± 2.25 days in these 691 patients included. the univariate analysis showed that colloidal infusion volume, crystal and colloid ratio, baseline C-reactive protein level, hypoalbuminemia and use of vasoactive drugs during operation were suspected factors of influencing postoperative defecation time (Figure A). After adjusting for these suspected variables, we found no relationship between the net fluid input and defecating time in elderly patients after radical gastrectomy (Fig. 6B).

Discussion

Fluid therapy serves to achieve homeostasis by restoring and maintaining body water, electrolytes and tissue perfusion[12, 13]. ERAS programs recommended to avoid too much intravenous fluid [14, 15]. Some studies determined restrictive fluid therapy to be optimal which reduced the complication rate compared with liberal fluid management policy[16]. However, inappropriate fluid-balance approaches may be harmful[2, 17]. Our findings showed that the incidence of AKI and PRCs in low intake group and high intake group increased when compared with medium intake group, no significant difference although. That is, liquid balance is not associated with postoperative clinical outcomes in aged patients undergone gastric cancer radical surgery. Myles' research found that restrictive fluid regimen was not associated with increased rate of disability-free survival and was associated with increased incidence of AKI compared with a liberal fluid therapy[7]. We suggest that the differences in the observed results may be due to our small sample size relatively and a single-center study.

AKI occurrence after operation could induce increased mortality, hospitalization and medical expenses[18, 19]. In our trial the mortality of AKI group was 6.25% while non-AKI group was 0.3% in hospital after operation(P = 0.068). No significant difference was found which may due to short follow-up time. However, noted that one third of the dead cases have been suffered from AKI. In addition, AKI group has longer hospital stays. Some studies found that body mass index, hyperlipidemia, preoperative use of ACE-I or ARB, COPD and diabetes could be the independent risk factors for AKI after postoperative[20–23]. Our findings showed that aged, anemia, preoperative coronary disease incidence low albumin level preoperative, decreased urine output and the use of Dizosin were associated with increased frequency of AKI. By multivariable analyses, the independent risk factors for AKI were preoperative coronary disease and decreased urine output. The decrease of urine volume during operation is the external sign of renal perfusion insufficiency, which is related to the occurrence of AKI. While in this study, we did not find that COPD, diabetes and so on were AKI Independent risk factors. We thought that the event rate of AKI was relatively low, which may have limited our ability to test for a large number of risk factors in a multivariable model.

Our study analyzed the risk for PRCs that is linked with commonly prescribed medications for comorbid conditions in subjects who undergo radical gastrectomy. The data indicate the occurrence of coronary disease and digestive tract obstruction preoperative were associated with increased odds for development of PRCs. Interestingly, Coronary heart disease preoperative turned out to be an independent risk factor both of AKI and PRCs in elderly patients after radical gastrectomy. The possible mechanism is that patients with a long history of coronary heart disease may result in ischemic cardiomyopathy, decreased cardiac contractility, and reduced cardiac output. The decrease of renal blood flow, difficult of pulmonary venous return, increased pressure in pulmonary capillaries and pulmonary interstitial edema, and this eventually developed into AKI and PRCs. Patients with digestive tract obstruction before operation are of inflammation and water electrolyte disorder in degree, which may be a potential mechanism of PRCs.

In conclusion, in patients at aged for complications while undergoing radical gastrectomy, fluid therapy was not associated with a higher rate of AKI and PRCs. Preoperative coronary disease and decreased urine output are independently associated with increased risk for postoperative AKI. Coronary disease and digestive tract obstruction preoperative were associated with increased incidence of PRCs. Limited by its retrospective design and relatively small sample size in our study, we suggest a larger-scale prospective study be conducted in future.

Abbreviations

AKI
acute kidney injury
PRCs
postoperative respiratory complications
FB
fluid balance
ASA
American Society of Anesthesiologists

Declarations

Ethics approval and consent to participate: This study was approved by the Affiliated Drum Tower Hospital of Nanjing University (Registration number: 2018-162-01).

Consent for publication: Not applicable.

Availability of data and materials: We declared that materials described in the manuscript, including all relevant raw data, will be freely available to any scientist wishing to use them for non-commercial purposes, without breaching participant confidentiality. If anyone wants to request the data from this study, please contact with corresponding author.

Competing interests: The authors declare that they have no competing interests.

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Authors' contributions: Yin Cui has seen the original study data, reviewed the analysis of the data, and was a major contributor in writing the manuscript. Yuhui Wu designed the study, conduct the study, analyze the data. Yan Su conducted the study. Beibei Zhu analyze the data. Zhengliang Ma helped design the study and write the manuscript. Tianjiao Xia helped analyzed the data and write the manuscript. Xiaoping Gu helped design the study and write the manuscript. All authors read and approved the final manuscript.

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Figures

factors	AKI	non-AKI	***P*** **value**
cases	16	675	
preoperative			
male(%)	15(93.75)	548(81.19)	0.784
age（year)	74.50±5.23	71.85±4.88	0.036
ASA degree(%)			0.137
II	1(6.25)	169(25.04)	
III	15(93.75)	506(74.96)	
anemia(%)	10(62.50)	249（36.89)	0.036
hypoalbuminemia(%)	0(0,00)	5(0.74)	1.000
Hypertension(%)	10(62.50)	299(44.30)	0.203
Diabetes(%)	0(0.00)	86(12.74)	0.243
coronary disease(%)	3(18.75)	28(4.15)	0.031
Peripheral vascular disease(%)	0(0.00)	2(0.30)	1.000
history of cerebral infarction (%)	1(6.25)	61(9.05)	1.000
smoking history (%)	2(12.50)	93(13.80)	1.000
chronic bronchitis(%)	0(0.00)	7(1.05)	1.000
emphysema(%)	2(12.50)	16(2.37)	0.062
COPD(%)	0(0.00)	6(0.89)	1.000
preoperative gastrointestinal obstruction(%)	1(6.25)	15(2.22)	0.315
weight(Kg)	63.67±12.45	63.26±11.26	0.691
baseline creatinine(umol/l)	71.06±15.15	69.45±13.23	0.687
Baseline total protein(g/L)	59.44±6.34	61.02±5.83	0.421
Baseline albumin(g/L)	36.54±3.09	38.32±3.21	0.028
Baseline C-reactive protein(d)	4.70(2.85,5.80)	3.50(2.50,5.80)	0.639
baseline eGFR(ml/min/1.73m^2)	101.89±21.14	102.23±20.74	0.972
baseline fasting blood sugar(FBS) (mmol/L)	5.16±1.83	5.12±1.17	0.738
operative			
operative duration(h)	4.04±0.86	3.90±1.07	0.352
Type (%)			0.616
laparoscope	0（1.00)	43（6.37)	
laparotomy	16（100.00)	632（93.63)	
Furosemide (%)	3（18.75)	87（12.89)	0.452
Ulinastatin (%)	5(31.25)	204(30.22)	1.000
Dexamethasone (%)	5(31.25)	245(36.30)	0.678
Dezocine (%)	7(43.75)	467(69.19)	0.030
sevoflurane (%)	5(31.25)	107(15.85)	0.158
normal saline (ml)	0.00(0.00,25.00)	0.00(0.00,0.00)	0.203
Compound sodium chloride (ml)	0.00(0.00,1000.00)	0.00(0.00,500.00)	0.997
Sodium lactate Ringer solution(ml)	843.75±625.00	790.59±483.4	0.947
crystal(ml)	1425.00±502.66	1505.73±465.41	0.720
Succinyl gelatin(ml)	0.00(0.00,500.00)	0.00(0.00,500.00)	0.996
Hydroxyethyl starch(ml)	637.50±464.58	766.67±505.49	0.251
colloid(ml)	887.50.±330.40	1034.59±326.24	0.056
colloid types(%)			0.983
no useage of clloid	0(0.00)	2(0.30)	
Hydroxyethyl starch	11(68.75)	469(69.48)	
Succinyl gelatin	4(25.00)	150(22.22)	
both	1(6.25)	54(8.00)	
Crystal colloid ratio	1.70±0.59	1.57±0.68	0.224
blood transfusion(ml)	0.00(0.00,1000.00)	0.00(0.00,0.00)	0.558
blood loss(ml)	303.12±222.46	237.29±197.46	0.114
Urine volume(ml)	275.00(200.00,425.00)	500.00(300.00,800.00)	0.002
total input (ml)	2318.75±735.05	2546.47±650.39	0.324
totol output (ml)	700.00±360.56	877.76±521.00	0.168
input relatively(ml)	1618.75±567.71	1668.71±563.37	0.881
input relatively divided into groups(%)			0.244
low	6（37.50)	146（21.63)	
medium	5（31.25)	326（48.30)	
high	5（31.25)	203(30.07)	
postoperative			
total cost(yuan)	131737.29±57215.91	75083.10±15489.76	< 0.001
postoperative hospital stay(d)	16(14,27)	11(10,14)	< 0.001
total stay(d)	26(19,31)	18(15,21)	< 0.001
postoperative defecation time(d)	4(3.5,8.5)	6(4,7)	0.633
anastomtic leakage(%)	1(6.25)	8(1.19)	0.191
a second operation(%)	2(12.50)	5(0.74)	0.010
in-hospital death(%)	1(6.25)	2(0.30)	0.068
pulmonary complications(%)	3(18.75)	20(2.96)	0.014

Figure 1

Comparison of perioperative factors between AKI group and non-AKI group. [n (%), $\bar{x}$ ± *s*, M(Q1,Q3)]

	single factor		multiple factor	
Predictors	OR(95% CI)	*P* value	OR(95% CI)	*P* value
age（year）	1.1 (1.0, 1.2)	0.036	1.051（0.953,1.159）	0.317
Baseline total protein(g/L)	0.8 (0.7, 1.0)	0.029	0.866（0.713,1.05）	0.144
anemia	2.9 (1.0, 7.9)	0.045	1.364（0.399,4.668）	0.621
coronary disease	5.3 (1.4, 19.8)	0.012	4.867（1.142,20.75）	0.032
Dezocine	0.3 (0.1, 0.9)	0.038	0.357（0.125,1.022）	0.055
colloid volume(ml)	1.0 (1.0, 1.0)	0.072	1.0 （0.998,1.003）	0.692
Urine volume(ml)	1.0 (1.0, 1.0)	0.013	0.997（0.994,0.999）	0.017
input relatively divided into groups				
low	control		control	
medium	0.4 (0.1, 1.2)	0.108	0.577（0.206,1.615）	0.152
high	0.6 (0.2, 2.0)	0.405	0.617（0.195,1.953）	0.480

Figure 2

Regression model analysis of risk factors for the incidence of AKI

	uncorrected		corrected	
exposure variables	OR(95% CI)	*P* value	OR(95% CI)	*P* value
input relatively(100ml)	0.985 (0.902, 1.074)	0.726	1.016 (0.896, 1.153)	0.800
input relatively divided into groups				
low	control		control	
medium	0.373 (0.112, 1.245)	0.108	0.329 (0.072, 1.506)	0.152
high	0.599 (0.18, 2.001)	0.405	0.517 (0.084, 3.202)	0.480
P for trend		0.420		0.604

Figure 3

Relationship between intraoperative net fluid input and the incidence of AKI postoperative in different models

factors	PRCs	non-PRCs	*P* value
cases	23	668	
preoperative			
male(%)	20（86.96）	543（81.29）	0.784
age（year）	74.48±4.97	71.82±4.88	0.010
ASA degree(%)			0.137
II	6（26.09）	164（24.55）	
III	17（73.91）	504（75.45）	
anemia(%)	11（47.83）	248（37.13）	0.381
hypoalbuminemia(%)	0(0,00)	5(0.75)	1.000
Hypertension(%)	15（65.22）	294（44.01）	0.044
Diabetes(%)	2（8.70）	84（12.57）	0.757
coronary disease(%)	4（17.39）	27（4.05）	0.016
Peripheral vascular disease(%)	0(0.00)	2(0.30)	1.000
history of cerebral infarction (%)	0（0.00）	62（9.30）	0.254
smoking history (%)	3（13.04）	92（13.79）	1.000
chronic bronchitis(%)	0(0.00)	7(1.05)	1.000
emphysema(%)	2（8.70）	16（2.40）	0.117
COPD(%)	0(0.00)	6（0.90）	1.000
preoperative gastrointestinal obstruction(%)	3（13.04）	13（1.95）	0.014
weight(Kg)	61.45±8.97	63.34±11.35	0.425
baseline creatinine(umol/l)	68.26±12.93	69.53±13.28	0.669
Baseline total protein(g/L)	60.35±7.36	61.01±5.79	0.899
Baseline albumin(g/L)	38±3.39	38.28±3.21	0.643
Baseline C-reactive protein(d)	4.30（2.80,10.05）	3.50（2.50,5.75）	0.178
baseline eGFR(ml/min/1.73m^2)	104.67±21.30	102.14±20.73	0.663
baseline fasting blood sugar(FBS) (mmol/L)	4.98±1.25	5.13±1.18	0.328
operative			
operative duration(h)	4.07±0.97	3.90±1.07	0.327
Type (%)			0.389
laparoscope	0 (0.00)	43 (6.44)	
laparotomy	23 (100.00)	625 (93.56)	
Furosemide (%)	2 (8.70)	88 (13.17)	0.756
Ulinastatin (%)	7 (30.43)	202 (30.24)	0.984
Dexamethasone (%)	7 (30.43)	243 (36.38)	0.662
Dezocine (%)	17 (73.91)	457 (68.41)	0.655
sevoflurane (%)	3 (13.04)	109 (16.32)	1.000
normal saline (ml)	0（0,0)	0（0,0)	0.191
Compound sodium chloride (ml)	0（0,500)	0（0,500）	0.535
Sodium lactate Ringer solution(ml)	747.83±461.10	793.34±487.75	0.679
crystal(ml)	1469.57±438.42	1505.04±467.26	0.548
Succinyl gelatin(ml)	0（0,500)	0（0,500)	0.978
Hydroxyethyl starch(ml)	782.61±560.56	763.02±503.06	0.743
colloid(ml)	1043.48±366.59	1030.76±325.69	0.746
colloid types(%)			0.893
no useage of clloid	0(0.00)	2(0.30)	
Hydroxyethyl starch	16 (69.57)	464 (69.46)	
Succinyl gelatin	6 (26.09)	148 (22.16)	
both	1 (4.35)	54 (8.08)	
Crystal colloid ratio	1.58±0.69	1.57±0.68	0.770
blood transfusion(ml)	0（0,0)	0（0,0)	0.759
blood loss(ml)	280.43±159.36	237.38±199.28	0.083
Urine volume(ml)	300（250,550)	500（300,800)	0.043
total input (ml)	2513.04±672.38	2542.17±652.59	0.671
totol output (ml)	893.48±755.18	872.96±509.05	0.292
input relatively(ml)	1619.57±736.04	1669.21±556.85	0.661
input relatively divided into groups(%)			0.329
low	8 (34.78)	144 (21.56)	
medium	9 (39.13)	322 (48.20)	
high	6 (26.09)	202 (30.24)	
postoperative			
total cost(yuan)	94333.17±24537.90	75779.37±18981.69	< 0.001
postoperative hospital stay(d)	15.43±7.55	12.95±6.48	0.003
total stay(d)	22.70±8.40	19.07±7.10	< 0.001
postoperative defecation time(d)	6.38±2.78	5.72±2.27	0.193
anastomtic leakage(%)	1 (4.35)	8 (1.20)	0.264
a second operation(%)	1 (4.35)	6 (0.90)	0.212
in-hospital death(%)	0 (0.00)	3 (0.45)	1.000

Figure 4

Comparison of perioperative factors between PRCs group and non-PRCs group. [n (%), $\bar{x} \pm s$, M(Q1,Q3)]

A

	single factor		multiple factor	
Predictors	OR(95% CI)	*P* value	OR(95% CI)	*P* value
age（year)	1.102（1.021,1.189）	0.012	1.083（0.995,1.179）	0.066
Hypertension	2.385（0.998,5.702）	0.051	1.994（0.796,4.997）	0.141
coronary disease	4.99（1.588,15.680）	0.006	3.371（1.021,11.129）	0.049
emphysema	3.9（0.8,18.0）	0.083	3.456（0.689,17.339）	0.132
preoperative gastrointestinal obstruction	7.6（2.0,28.6）	0.003	12.501（3.058,51.107）	<0.0005
input relatively divided into groups				
low	control		control	
medium	0.503（0.190,1.330）	0.108	0.577（0.206,1.615）	0.295
high	0.535（0.182,1.574）	0.256	0.617（0.195,1.953）	0.412

B

	uncorrected		corrected	
exposure variables	OR(95% CI)	*P* value	OR(95% CI)	*P* value
input relatively(100ml)	0.985 (0.915, 1.059)	0.677	0.998 (0.927, 1.076)	0.965
input relatively divided into groups				
low	control		control	
medium	0.503 (0.190, 1.330)	0.108	0.577 (0.206, 1.615)	0.295
high	0.535 (0.181, 1.574)	0.255	0.618 (0.195, 1.953)	0.412
P for trend		0.255		0.406

Figure 5

A. Regression model analysis of risk factors for the incidence of PRCs

B. Relationship between intraoperative net fluid input and the incidence of PRCs postoperative in different models

A

Predictors	single factor		
	β	95% CI	*P* value
Baseline C-reactive protein	0.009	-0.003-0.021	0.128
hypoalbuminemia	2.3	0.3-4.3	0.027
use of vasoactive drugs	-1	-1.7-0.2	0.006
colloid	0.001	-0.000021-0.001	0.060
Crystal colloid ratio	-0.237	-0.493-0.019	0.070

B

exposure variables	uncorrected		corrected	
	β(95% CI)	*P* value	β(95% CI)	*P* value
input relatively(100ml)	0.005 (-0.026, 0.036)	0.7526	-0.0002 (-0.039,0.038)	0.991
input relatively divided into groups				
low	control		control	
medium	-0.056 (-0.505,0.392)	0.805	-0.156 (-0.619, 0.307)	0.509
high	-0.052 (-0.540,0.436)	0.835	-0.172(-0.752,0.409)	0.563
P for trend		0.849		0.571

Figure 6

A. Single factor analysis of postoperative defecation time

B. The relationship between the net fluid input and defecating time after radical gastrectomy