Influence of acute hypervolemic hemodilution with different intravascular volume replacement on blood coagulation and renal function in elderly patients

Li Li*, Zhisong Li, Yanqiu Ai, Zhongyu Wang

Department of Anesthesia, The First Affiliated Hospital of Zhengzhou University, Zhengzhou, Henan 450052*, China*

Received September 12, 2008

Abstract

Objective. To investigate the influence of acute hypervolemic hemodilution (AHH) with different intravascular volume replacement on blood coagulation and renal function in elderly patients. *Methods.* Thirty patients (aged > 60 years and < 75 years) were randomly divided into three groups. AHH was administrated with 6% HES (200/0.5) and 4% gelofusine in group A and B, respectively. AHH was not administrated in group C. PT, APTT, FIB, BUN, CR and NAG were measured at T1 (before AHH administration), T2 (at the end of AHH), T3 (60 minutes after AHH), T4 (at the end of surgery) and T5 (on the first morning after surgery). *Results.* APTT of group A at T2 and T3 was significantly longer than that at T1 ($P < 0.05$). There were no significant differences of FIB and APTT among groups but the FIB were significantly higher at T5 than that at T1 in three groups ($P < 0.05$). Serum concentrations of CR and BUN were normal during the study. NAG at T3 – T5 were higher than that at T1 and reached peak at T4 and there was no significant difference among groups. *Conclusion.* Preoperative AHH with HES or gelofusine has no detrimental effect on blood coagulation and renal function in elderly patients. [Life Science Journal. 2008; 5(4): 38 – 40] (ISSN: 1097 – 8135).

Keywords: hemodilution; blood coagulation; renal function

1 Introduction

The technique of acute hypervolemic hemodilution (AHH) can provide circulatory stability and limit the use of allogenenic blood. In the mean time it influences the body's physiological function in a certain degree. Previous reports on AHH are mostly about the administration in adults[1–3]. The effect on physiological function in elderly patients needs further examination. The present prospective, randomized, double-blinded study investigates the influence of acute hypervolemic hemodilution with different intravascular volume replacement on blood coagulation and renal function in elderly patients.

2 Materials and Methods

2.1 Subjects

After approval of the local ethics committee and informed written consent, 30 patients (aged between 60 – 75 years old, ASA I or II, 50 – 75 kg) scheduled for elective abdominal surgery were randomly divided into three groups: group A, who received intravenously infusion of 15 ml/kg 6% HES (200/0.5) solution (ME3215, Fresenius Kabi Company, German) at the rate of 25 ml/min immediately after anesthesia induction began; group B, who received infusion of 15 ml/kg with 4% gelofusine solution simutanously (2231Q47, B.Braun Company, German) at the same rate; control group (C), who received infusion of LR (lacted ringer's solution) at the rate of 15 ml/(kg·h). Exclusion criteria were hematocrit (HCT) < 34% or > 44%, hemoglobin (HB) < 110 g/L, history of cardiopulmonary dysfunction or coagulopathies, impaired renal or liver function. Before administration of AHH, each patient was infused LR 6 – 8 ml/kg intravenously to compensated for the fluid loss induced by 8 hours' fasting. Internal jugular vein was canulated for infusion and central venous pressure (CVP) monitoring. The patients were unpremedicated. Anesthesia was induced with fentanyl 1 – 1.5 μg/kg, droperidol 1 mg, propofol 1.5 – 2 mg/kg and

*Corresponding author. Email: koppleleelili@163.com

succinylcholine 1 – 1.5 mg/kg and maintained with 60% N_2O and 1.5% – 2.5% isoflurane inhalation and intermittent *iv* boluses of vecuronium and fentanyl. Adjust the concentration of isoflurane inhalation to maintain hemodynamic stability according to the CVP and MAP values. Intravenous bolus of ephedrine 5 mg repeated at 5 minutes intervals was given when MAP decreased to less than 80% of the baseline value.

2.2 Measurement

ECG, mean arterial pressure (MAP), CVP and SpO_2 were continuously monitored during study. MAP, HR and CVP were recorded before AHH administration (T1), 5 minutes during AHH (T1.1), 10 minutes during AHH (T1.2), 15 minutes during AHH (T1.3), 20 minutes during AHH (T1.4), at the end of AHH (T2), 60 minutes after AHH (T3), and at the end of surgery (T4). Hematocrit (HCT), hemoglobin (HB), prothrombin time (PT), activated partial thromboplastin time (APTT), fibrinogen (FIB), blood urea nitrogen (BUN), creatinine (Cr) and n-acetyl-β-d- glucosaminidase (NAG) were measured at T1, T2, T3, T4 and T5 (on the first morning after surgery).

2.3 Statistical analysis

All experimental data were processed by SPSS11.0 and expressed as mean ± SD. One-factor analysis of variance and analysis of variance for repeated measurements were used to evaluate the significance. $P < 0.05$ was considered significant.

3 Results

There were no significant differences among three groups on age, weight, baseline value of HCT and operation time ($P > 0.05$) (Table 1).

The hemodynamic parameters maintained stable during the study. None of the patient's CVP increased above 12 cmH_2O.

PT was normal during the study in all groups. APTT was longer than baseline value at T2 and T3 in group A ($P < 0.05$). FIB concentration increased at T5 in all groups ($P < 0.05$). Serum concentration of BUN and Cr were normal during the study in three groups. Urinary NAG was elevated at T3, T4, T5, and reached peak at T4 in three groups ($P < 0.05$). In terms of these parameters above mentioned there was no significant difference among three groups (Table 2).

4 Discussion

Our study showed that the hemodynamic parameters maintained stable during AHH and the study. None of the patient's CVP increased above 12 cmH_2O in AHH groups. It indicated that AHH administrated during induction period of general anesthesia can be well tolerant in elderly patients.

Table 1. Demographic characterization of study groups ($\bar{X}$ ± SD)

Group	Cases (*n*)	Age (years)	Weight (Kg)	Baseline value of HCT (%)	Operation time (hour)
A	10	65.7 ± 4.1	63.5 ± 6.3	36.7 ± 9.1	3.9 ± 0.5
B	10	66.9 ± 3.8	65.2 ± 5.4	37.2 ± 5.4	3.5 ± 0.5
C	10	67.5 ± 4.9	63.6 ± 7.6	38.1 ± 1.6	3.9 ± 0.5

Table 2. Measurements of coagulation function and urinal NAG at different time ($\bar{X}$ ± SD)

Variables	Group	T1	T2	T3	T4	T5
APTT (Second)	A	33.31 ± 2.75	41.52 ± 5.25*	38.28 ± 2.07*	35.43 ± 3.65	34.29 ± 3.20
	B	36.09 ± 4.20	38.49 ± 4.29	35.33 ± 4.06	36.41 ± 3.44	34.06 ± 2.49
	C	34.52 ± 3.60	35.73 ± 3.29	34.46 ± 2.66	35.37 ± 3.26	35.54 ± 2.72
FIB (Second)	A	3.49 ± 0.77	3.10 ± 0.68	3.20 ± 0.66	3.15 ± 0.70	4.24 ± 0.84*
	B	3.34 ± 0.75	3.02.± 0.70	2.89 ± 0.58	2.94 ± 0.67	3.97 ± 0.73*
	C	3.43 ± 0.48	3.64 ± 0.69	3.52 ± 0.62	3.36 ± 0.66	4.25 ± 0.44*
NAG (U/g·Cr)	A	15.63 ± 7.10	20.33 ± 11.99	28.30 ± 8.38*	32.04 ± 16.80*	26.27 ± 15.33*
	B	14.68 ± 8.70	17.87 ± 10.53	25.95 ± 4.94*	34.56 ± 12.04*	22.76 ± 10.48*
	C	24.09 ± 16.65	25.64 ± 14.47	37.07 ± 27.53*	40.21 ± 23.20*	30.56 ± 16.21*

*$P < 0.05$, compared with the baseline value.

4.1 Coagulation function

Coagulation alternations during AHH is mainly related with the extent of hemodilution and the physico-chemical properties of colloids used during hemodilution. HES and gelofusine are the most frequently used colloids in clinic. 6% HES (200/0.5) is the second generation of HES. Its effect on coagulation function is controversial[4]. Our study showed that APTT prolonged in those received HES. Although this prolongation has a statistical significance, it has no clinic significance when the prolongation is less than 5 seconds. And PT, APTT have no significant differences among groups. So, the prolongation of APTT in group HES may be reduced by blood hemodilution after colloid infusion and has no relationship with the solution used. Postoperative hypercoagulation state may explain the increase of FIB on the first morning after surgery in all groups.

4.2 Renal function

The ability to compensate disturbances of renal function decreases with age[5]. Renal function in the elderly often deteriorates sharply when suffered from unstable hemodynamics state, inflammation, surgery and anesthesia and so on. It is of importance whether colloids can be used safely for intravascular volume replacement in these patients. The effect of colloids on renal function is the most concerned in clinic. Apart from the conventional renal function examination, our study used new and more sensitive marker – NAG. NAG is a lysosomal enzyme mainly of the proximal tubular cells. An increasing NAG leakage to urine has been shown in the presence of tubular lesions[6]. It seems to be another early marker for detecting renal dysfunction. We observed that the baseline value of NAG in group C exceeded normal range, and in group A and B was close to the upper limit of the normal range. NAG increased with time and reached peak at the end of surgery. Though decreased on the first morning after surgery NAG was still at high level as compared with baseline. The increase-with-time curve is similar among three groups, which indicated this change of NAG had no direct relationship with AHH or the infused solution. It may be induced by traumatic procedure during surgery and anesthesia. This result showed that elderly patients have some changes in renal function before operation and further reduction is seen perioperatively. So monitoring on renal function and closely investigation during AHH in the elderly is recommended.

5 Conclusion

We concluded that volume replacement with 6% HES (200/0.5) solution or 4% gelofusine has no detrimental effect on coagulation and renal function in the elderly without related with preoperative dysfunction. AHH with the two colloids can be used in elderly patients without cardiopulmonary dysfunction and coagulopathies or renal malfunction.

References

1. Xiao H, Du B, Xu H. Application of acute extreme hypervolemic hemodilution in spine surgery. Chinese Journal of Reparative and Reconstructive Surgery 2007; 21(10): 1090 – 3.
2. Liang H, Yang CX, Li H, *et al.* Effects of preoperative acute hypervolemic hemodilution on hypercoagulability of patients with colon cancer. Chinese Journal of Cancer 2006; 25(10): 1256 – 60.
3. Fukusaki M, Kanaide M, Inadomi C, *et al*. The effect of sevoflurane -induced hypotension in combination with acute hypervolaemic haemodilution on middle cerebral artery flow velocity in surgical patients. Eur J Anaesthesiol 2008; 1: 1 – 5.
4. Konrad CJ, Markl TJ, Schuepfer GK, *et al. In vitro* effects of different medium molecular hydroxyethyl starch, and lactated Ringer's solution on coagulation using SONOCLOT. Anseth Analg 2000; 90(2): 274 – 9.
5. Duan YP, Lin QS, Li ZG, *et al.* Analysis of renal function in 1743 cases from different population. Journal of Hunan Medical University 1999; 24(5): 425 – 8.
6. Price RG. Measurement of N-acetyl-ß-glucosaminidase and its isoenzymes in urine methods and clinic applications. Eur J Clin Chem Clin Biochem 1992; 30(8): 693 – 705.