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Letter to Editor

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Effects of potassium adsorption filters on the clotting activity of fresh frozen plasma

Abstract

Background: Recent studies report high levels of ammonia in plasma frozen at −20°C and stored from 5 to 8months which leads to neurotoxicity to the brain. It has been proved that the Potassium Adsorption Filter (PAF) can remove Potassium and Ammonia from red blood solutions. This study was aimed at measuring the the effects of PAF on the clotting activity of FFP.

Materials and methods: FFP in the experiments was obtained from Japan Red Cross Society. Ammonia and potassium concentration, clotting factor activity (factor II, factor V, factor VII, factor VIII, factor IX, factor XI, von Willebrand factor) and clotting tests including activated partial thromboplastin time, % prothrombin time and fibrinogen in the thawed plasma were measured by Biomedical Laboratories and compared with those in the plasma post-filtration (KPF-1, Kawasumi Laboratories Incorporated). After priming the PAF with 200mL of saline, saline was removed before the PAF use.

Results: There were no differences of clotting tests, clotting factor activity in the thawed FFP between pre-filter and post-filter, while PAF reduced the potassium and ammonia concentration in the thawed plasma.

Discussion: Plasma transfusion for traumatic brain injury, severe hepatic failure, or neonate with severe liver disease may be required for PAF, in order to avoid un-necessary ammonia containing the plasma.

Keywords: FFP, PAF, KPF-1, aPTT, plasma, prothrombin

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Introduction

We have previously reported the applicability of a potassium adsorption filter (PAF) at the bedside to remove potassium and ammonium ions from blood products,[1] based on the ability of this resin filter to absorb K^+ or NH_4^+ and release sodium ions in equivalent amounts.[2] Fresh frozen plasma (FFP) was transfused into patients with liver cirrhosis or neonates with urea cycle disorder to correct coagulation disorders or deficiencies; however, FFP itself has a higher ammonia level compared to the normal reference levels.[1,3] In this letter, we show the effects of the PAF on clotting activities and the levels of potassium and ammonia in FFP. Two hundred and forty milliliters of FFP within the expiry date was obtained from the Japan Red Cross Society (Tokyo, Japan). The FFP was thawed by using a recirculating water bath thawing system at 37°C (FF-40, Kawasumi Laboratories Incorporated, Oita, Japan). After dissolving, the 240mL of thawed FFP was divided into two bags, each containing 120mL of FFP. Three parent packs of FFP were used in the experiment (bag 1-2: blood type A, bag 3: blood type B, Table 1) within one hour after dissolving. The PAF (KPF-1, Kawasumi Laboratories Incorporated, Oita, Japan) was primed with saline (Terumo Corporation, Tokyo, Japan), and then the saline was removed from the PAF before use. Two hundred forty milliliters of thawed FFP was filtered, at a flow rate of approximately 20mL/min, and the plasma passing through the PAF was collected into empty bags. Levels of potassium and ammonia (N=4, each bag of pre-, post-filter) and activities of clotting factor (factor II, factor V, factor VII, factor VIII, factor IX, factor XI, von Willebrand factor, N=1, each bag of pre-, post-filter) were measured and clotting testing for activated partial thromboplastin time (aPTT), % prothrombin time (%PT), and fibrinogen (N=4, each bag of pre-, post-filter) was performed on the thawed plasma collected into the empty bags, by Biomedical Laboratories Company (Tokyo, Japan) and the values were compared with the respective concentrations and activities in thawed plasma before passaging through the PAF. The study design was approved by the ethics review board of our institution.

Ammonia levels were high in the thawed FFP solution (ammonia: ~100–132µg/dL), whereas potassium levels were lower than the normal values (K: ~2.9–3.1mmol/L), (Table 1). Potassium and ammonia levels in FFP were decreased significantly post-filtration (Table 1). aPTT slightly increased significantly in four of the six passaged bags. % PT slightly decreased significantly in one of the six passaged bags. Fibrinogen level slightly decreased significantly in three of the six passaged bags (Table 1). However, filtration did not affect aPTT, %PT, and fibrinogen on the whole. Filtration did not affect clotting factor activities (factor II, factor V, factor VII, factor VIII, factor IX, factor XI, von Willebrand factor) in the FFP (Table 2). Thus, this study shows increased levels of ammonia in FFP within the expiry date and that the PAF is useful for the removal of ammonia from FFP without reducing its clotting activity. We expect that PAFs will be clinically useful for FFP transfusion in neonates, or in traumatic brain injury. Recently, small-sized PAF for neonate (PAF–n) was introduced in Japan, and we reported that ammonia and potassium were removed from small satellite bags of red blood cell solution using the PAF–n.[4] We will examine the effects of PAF-n on ammonia, potassium and clotting factor activities in FFP.

Table 1 Effects of potassium adsorption filter on clotting tests, potassium and ammonia in thawed fresh frozen plasma

	Separated bag	Activated thromboplastin time (sec)	% Prothrombin time (%)	Fibrinogen (mg/dL)	Potassium (mmol/L)	Ammonia (μg/dL)
Pre-filter	Bag 1-1	37.7 (0.2)	83.5 (0.6)	224 (1)	3.0 (0.0)	132 (3)
	Bag 1-2	37.8 (0.1)	85.6 (0.4)	223 (1)	3.0 (0.0)	132 (1)
	Bag 2-1	39.0 (0.1)	110.1 (1.0)	313 (2)	3.1 (0.0)	103 (1)
	Bag 2-2	38.9 (0.2)	110.6 (1.0)	316 (0)	3.1 (0.0)	100 (6)
	Bag 3-1	39.3 (0.0)	100.9 (0.5)	159 (1)	2.9 (0.0)	127 (3)
	Bag 3-2	38.0 (0.2)	101.7 (1.5)	171 (1)	2.9 (0.0)	121 (2)
Post-filter	Bag 1-1	38.8 (0.1)*	84.9 (0.6)	222 (1)	0.8 (0.0)*	71 (1)*
	Bag 1-2	38.9 (0.1)*	84.2 (0.4)	222 (1)	1.0 (0.0)*	72 (1)*
	Bag 2-1	39.5 (0.1)	107.2 (0)*	305 (0)*	1.2 (0.0)*	73 (1)*
	Bag 2-2	40.0 (0.0)	109.1 (0.8)	310 (2)	1.1 (0.0)*	70 (2)*
	Bag 3-1	40.5 (0.1)*	98 (0.4)	133 (1)*	1.0 (0.0)*	77 (1)*
	Bag 3-2	39.1 (0.1)*	97.2 (0.4)	163 (1)*	0.9 (0.0)*	73 (1)*

We compared the differences in potassium, ammonia concentration and clotting activity between samples before and after filtration by Wilcoxon's analysis. Data are expressed as group means ± standard errors of the mean. All statistical calculations were performed using JMP version 8.0 software (SAS Institute, Inc., Cary, NC), and significance was defined as $p<0.05$.

Data represent the means with the standard errors in parentheses (N=4). *: $p<0.05$ vs. pre-filter

Bag1~2: blood type A, Bag3: blood type B

Table 2 Effects of potassium adsorption filter on the clotting factor activity in thawed fresh frozen plasma

	Factor II (%)	Factor V (%)	Factor VII (%)	Factor VIII (%)	Factor IX (%)	Factor XI (%)	von Willebrand factor (%)
Pre-filter	103	91	104	55	97	103	67
	(2)	(3)	(7)	(8)	(7)	(3)	(7)
Post-filter	102	88	104	51	96	102	66
	(2)	(3)	(7)	(7)	(7)	(3)	(8)

We compared the differences in potassium, ammonia concentration and clotting activity between samples before and after filtration by Wilcoxon's analysis. Data are expressed as group means ± standard errors of the mean. All statistical calculations were performed using JMP version 8.0 software (SAS Institute, Inc., Cary, NC), and significance was defined as $p<0.05$.

Data represent the means with the standard errors in parentheses (N=6 bags).

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Conflict of interest

The author declares that there is no conflict of interest.

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