Original Article

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Thawing Time Difference between Fresh Frozen Plasma Using Ziplock Plastic and non-Ziplock Plastic in Blood Transfusion Unit Dr. Hasan Sadikin General Hospital Bandung, Indonesia

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Abstract

Background: The quality of fresh frozen plasma (FFP) in a clinical setting depends on thawing time. Thawing using a water bath is often used in blood transfusion units because it is easy to perform, affordable, and easy to look for. Protective plastics (Ziplock and non-Ziplock) are used to reduce the risk of contamination. This study aimed to determine whether there is a difference in thawing time between FFP using Ziplock plastic and non-Ziplock plastic.

Methods: This experimental design was conducted in the Blood Bank Unit of Dr. Hasan Sadikin General Hospital Bandung, Indonesia from June–August 2021. Samples were divided into two groups, namely thawing using Ziplock and non-Ziplock. Each group consisted of volume 160–200 mL and 201–240 mL.

Results: The total samples were 24 FFP bags. In the group of the bag 160–200 mL, the median thawing time using Ziplock plastic was 8 minutes (8–16 minutes), non-Ziplock was 15 minutes (8–16 minutes) (p=0.111), whereas in a group of bags with volume 201–240 mL, the median thawing time using Ziplock was 15 minutes (8–28 minutes), non-Ziplock was 20 minutes (14–30 minutes) (p=0.332). Although there was a time difference in both groups, the difference was non-significant.

Conclusions: The thawing time between the small bag with a volume of 160–200 mL and the larger volume of 201–240 mL shows no difference. Ziplock plastic can be used to reduce the risk of contamination.

Keywords: FFP, non-Ziplock plastic, thawing time, water bath, Ziplock plastic

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Introduction

Fresh frozen plasma (FFP) is prepared from single units of whole blood or plasma collected from apheresis techniques. It is frozen at -18 to -30 °C within eight hours of collection and, when appropriately stored, is usable for one year from the collection date.[1,2] Fresh frozen plasma contains fibrinogen (400 to 900 mg/unit), albumin, protein C, protein S, antithrombin, and tissue factor pathway inhibitors.[2,3] The FFP transfusion is used to replace some coagulation factors and is indicated in patients who experience bleeding with a history of routine use of warfarin who will undergo invasive procedures, thrombotic thrombocytopenia purpura (TTP), hemolytic uremic syndrome (HUS), deficiency of coagulation factors, massive transfusion in hypocoagulable and hypovolemic patients. After FFP transfusion, coagulation factors will increase by as much as 20%.[1,4,5]

Bleeding cases requiring FFP transfusion, the administration of FFP depends on the rate at which FFP is thawed.[6,7] Before a frozen bag of plasma can be used for transfusion, it should be warmed to a desired transfusable temperature.[8] Several tools can be used to defrost FFP, namely a dry oven (incubator with temperature control) which requires a fast defrosting time of 10 minutes and is able to reduce the risk of contamination by bacteria.[9]

The second tool is a microwave oven; the advantage of this tool is that it has the fastest defrosting ability compared to other methods, which is ±2–3 minutes; the disadvantages are that it is expensive and has limited capacity.[9] The third tool is a water bath, the advantage of this tool is that it is easy to use by placing the FFP into a water bath whose temperature has been set between 30–37 °C for 20–30 minutes and the price is relatively affordable and easy to obtain, the disadvantage is that there is a risk of contamination when defrosting it without protective plastic.[10] Among the three FFP liquefaction tools, the water bath is the most frequently used.[11,12] A good quality FFP bag must meet several requirements such as being resistant to cold and hot temperatures, mechanically resistant, not releasing harmful substances into blood components, and having no color (transparent). Materials that meet these requirements are polyvinyl chloride (PVC).[2,12] The use of plastic bags is highly recommended for thawing FFP in water bath to avoid contamination by bacteria. Defrosting FFP in the water bath without using protective plastic will increase the risk of septicemia as reported in a study conducted in Germany,[10] which found cases of septicemia caused by *Pseudomonas aeruginosa* due to thawing of FFP in water bath that were not coated with plastic. Further research shows that a liquid volume of 0.025 mL on thawing without using plastic will increase the infection rate.[10] Therefore, the plastic bags used in the FFP liquefaction process must be resistant to chemicals, and water vapor, have a high melting point (115–135 °C), be easy to obtain, and be inexpensive.[12,13] The best plastic material for this purpose is polyethylene, which consists of high-density polyethylene (HDPE) and low-density polyethylene (LDPE).[14]

Factors that can affect the thawing time of FFP are volume, number of bags of FFP being defrosted simultaneously, thawing temperature, and the type of protective plastic. According to research in London, the larger the volume of disbursed FFP, the longer it will take to melt.[15,16] Other studies stated that the melting time of FFP without the use of plastic at 37 °C takes 17 minutes, and the melting process using plastic at the same temperature takes 28 minutes. Although faster, thawing of FFP without the use of plastic can pose a risk of septicemia.[17–19] Dry ovens and microwave ovens are rarely available and more expensive than water bath. Therefore, the use of a water bath can help hospitals or blood care units to choose which method has the fastest thawing time without risking contamination. This study aimed to analyze the difference in the thawing time of FFP using Ziplock and non-Ziplock plastics. Ziplock plastic is a resealable sliding storage, container plastics, and non-Ziplock plastic in this study is a yellow plastic used to store or dispose medical items. These plastics can be seen in Figure 1.

A B

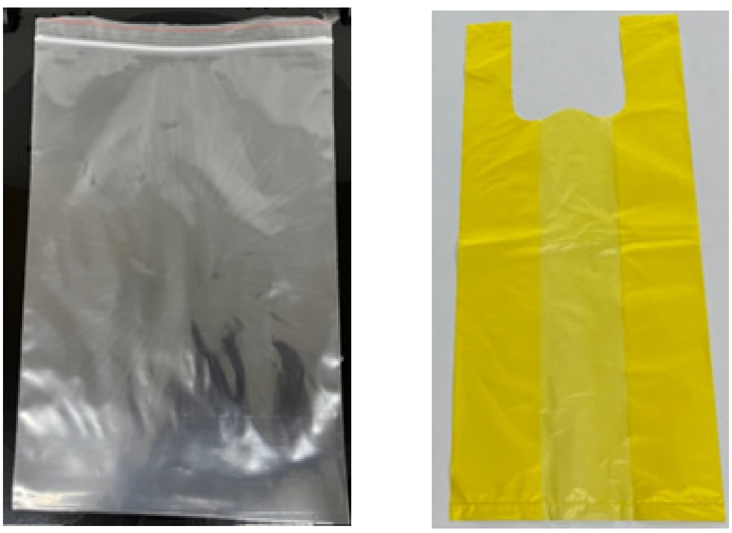

Figure 1 Protective Plastics

Note: A= Ziplock plastic, B= Non-Ziplock plastic

Table 1 Data Characteristics of FFP Samples

Sample Characteristics (Blood Type)	Ziplock n	Non-Ziplock n
Blood type		
A+	3	2
B+	1	3
AB+	0	1
O+	8	6

Methods

This study used an experimental method with a sample size of 24 FFP bags determined based on the Federer formula.[20] The study was conducted at the Blood Services Unit of Dr. Hasan Sadikin General Hospital Bandung, Indonesia from June to August 2021.

This study used an FFP bag that was used commercially and met the predetermined volume groups, namely 160–200 mL and 201–240 mL. Apart from volume, the FFP groups were divided into two groups of defrosting, using Ziplock and non-Ziplock plastic bags. Before thawing, water bath was warmed until 37 °C for 10 minutes in the Ziplock and non-Ziplock groups. The chi-square test was carried out to determine the characteristics of the data, the normality test of the data using Shapiro-Wilk followed by a different test using Mann Whitney for the analysis of time differences with p-value <0.05 was considered significant. This study protocol was approved by the Ethical Committee of Dr. Hasan Sadikin General Hospital Bandung, Indonesia, with number LB.02.01/X.6.5/253/2021.

Results

During the study, 24 samples were obtained, with a description of the characteristics listed in Table 1. This study found that the highest demand for FFP was in the O+ blood group, both from the Ziplock and non-Ziplock groups, and the least demand was in the AB+ blood group, both from the Ziplock and non-Ziplock groups (Table 1).

Volume in the Ziplock group was less than in the non-Ziplock group, but the difference was not significant (Table 2). The data normality test was carried out using Shapiro Wilk and the data was not normally distributed, followed by the Mann-Whitney test to analyse the difference in thawing time between FFP using Ziplock and non-Ziplock plastic (Table 3). From the analysis results, there was a non-significant time difference between thawing using Ziplock and non-Ziplock plastics (Table 3).

Discussion

From the data characteristics in Table 1, it is found that the most blood type is O+ and

Table 2 Comparison of Volumes Using Zip Lock and non-Zip Lock Plastics

	Ziplock Plastic (n=12)	Non-Ziplock Plastic (n=12)	p-value
	Median (Min.–Max.)	Median (Min.–Max.)	
Volume (mL)	201(180–220)	208 (183–239)	0.524

Table 3 Comparison of FFP Thawing Time Using Ziplock Plastic and non-Ziplock Plastic

FFP Bag Volume	Thawing Time (Minute)		Median Difference (95% CI)	p-value
	Ziplock Plastic (n=12)	Non-Ziplock Plastic (n=12)		
	Median (Min.–Max.)	Median (Min.–Max.)		
160–200 mL	8 (8–16)	15 (8–16)	-7 (-8–0)	0.11
201–240 mL	15 (8–28)	20 (14–30)	-5 (-15–8)	0.33

the least is AB+. This is in accordance with research in India,[11] that out of a total of 10,000 donors, blood type O+ is the most common (37.1%) followed by B+ (32.3%), A+ (22.8%), and AB+ (7.7%). The distribution of this blood group corresponds to the percentage in the world, which is the most O+ blood group.[21,22]

The result of this study showed that there was no significant difference in thawing time using Ziplock and non-Ziplock plastic. The difference in thawing time is not significant because thawing time is mainly influenced by the volume of FFP, not the type of plastic.[23] In our study, the more the volume, the longer the thawing time. The theoretical basis for this statement is that the more volume, the greater the heat transfer required for thawing. This is in accordance with another research which carried out the thawing process using a microwave assisted thawing apparatus in a food system model with a thick and homogeneous consistency. There was no significant change in volume during the freezing and thawing process. The model was divided into two treatment groups, namely samples with a thickness of 3.6 cm and 5.5 cm. From this study, it was found that volume was the factor that most significant affecting the thawing time, samples with a thickness of 5.5 cm took three times longer than samples with a thickness of 3.6 cm. From these research, it was found that volume is the factor that most influences thawing time.[22,23]

Ziplock plastic base material is LDPE with a thickness of ±0.5 mm, thinner than non-Ziplock plastic with a thicker HDPE base material (10–30 mm). In addition, the Ziplock plastic has a tight plastic tip, so that no air comes in and out during defrosting process, and the temperature during defrosting is stable. In contrast to non-Ziplock plastic, which does not have a tight end, causing air to enter and exit during defrosting so that the temperature during defrosting is unstable, this also causes non-Ziplock plastic not to be completely submerged during defrosting, in contrast to Ziplock plastic which is completely submerged.[22,23]

Although not significantly different, defrosting using Ziplock plastic can be an option in daily practice since the melting temperature is stable and can reduce the risk of contamination because LDPE plastic is resistant to high temperatures up to 90 °C.

There are several limitations in this study, namely that temperature measurements were not performed at the end of defrosting process; no hemostasis tests were carried out after the defrosting process; no culture examination was performed after defrosting to determine whether contamination occurred.

In conclusion, there is no significant difference in the duration of FFP thawing using Ziplock and non-Ziplock plastic. However, Ziplock plastic can be an option to reduce the risk of contamination.

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