EFFECT OF PREOPERATIVE PLATELET SEPARATION AND REINFUSION ON BLOOD SAVING EFFECT, BLOOD FIBRINOLYTIC SYSTEM, BLOOD OXYGEN METABOLISM, PLATELET AND COAGULATION FUNCTION IN PATIENTS UNDERGOING HEART VALVE REPLACEMENT

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ABSTRACT

Objective*: To analyse the effects of preoperative platelet separation and reinfusion on blood-saving effect, blood fibrinolytic system, blood oxygen metabolism and platelet coagulation in patients undergoing heart valve replacement.*

Methods: *A total of 86 patients with cardiac valve replacement admitted to the cardiac surgery department of our hospital from March 2015 to May 2018 were selected. Among them, 43 cases were in the observation group (underwent platelet separation and reinfusion) and 43 cases were in the control group (did not undergo platelet separation and reinfusion). The effects on postoperative blood-saving effect, blood fibrinolytic system, blood oxygen metabolism and platelet and coagulation function were compared between the two groups.*

Results: *The amount of allogeneic blood infusion in the observation group was significantly lower than that in the control group, and the difference was statistically significant ($p<0.05$). There was no statistically significant difference in other indicators between the two groups ($p>.05$). Before treatment, FDP, D-Dimer and CM-140 in the two groups showed no statistically significant difference ($p>.05$). After surgery, FDP, D-Dimer and CM-140 in the two groups were significantly higher than before treatment, and the observation group was significantly lower than the control group, with a statistically significant difference ($p<.05$). Compared with time point F1 in the observation group, DO2 at time point F3 in the control group decreased and ERO2 increased, with a statistically significant difference ($p<.05$). There was no significant difference in other indicators between the two groups ($p>.05$). Platelet count, fibrinogen, prothrombin time and thrombin time were significantly reduced in the two groups at 1 h after surgery ($p<.05$). The platelet count in the observation group was significantly higher than in the control group at 1 h after operation ($p<.05$). There was no significant difference between other indexes in the other time points of the observation group and the control group ($p>.05$).*

Conclusion: *During a heart valve replacement surgery, platelet separation and reinfusion can protect the blood coagulation system, reduce allogeneic blood input, avoid postoperative haemorrhage and improve platelet coagulation and the function of the blood fibrinolytic system. This procedure is worthy of clinical application.*

Keywords: *Platelet separation and reinfusion, heart valve replacement surgery, blood-saving effect, blood fibrinolytic system, blood oxygen metabolism, platelets, coagulation function.*

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Introduction

Heart valve replacement, or biological valve replacement surgery, uses an artificial mechanical valve made of biological tissue. The artificial valve has a strong tolerance and durability, but is it prone to complications such as thromboembolism and abnormal coagulation function, and the patient must be anticoagulant for life[1]. Platelet separation and reinfusion is the separation of platelets from the whole blood into platelet-rich plasma[2], which can reduce intraoperative and postoperative bleeding[3]. Studies have shown that platelet reinfusion can improve coagulation dysfunction caused by blood dilution[4].

At present, there are few reports on the effects of preoperative platelet separation and reinfusion on postoperative heart valve replacement patients, so this paper will explore the effects of preoperative platelet separation and reinfusion on postoperative blood-saving effect, blood fibrinolysis system, blood

oxygen metabolism, platelet and coagulation function in patients with heart valve replacement, as reported below.

Materials and methods

General information

A total of 86 patients with cardiac valve replacement in our hospital were selected for comparative analysis. They were divided into the observation group (43 cases with platelet separation and reinfusion) and the control group (43 cases without platelet separation and reinfusion). The observation group was 43~75 years old, with an average (61.56±12.62) years old and a weight of 63~67 kg, with an average (64.23±1.13) kg; The control group was 44~76 years old, with an average (62.21±13.54) years old and a weight of 62~66 kg, with an average (63.21±1.12) kg.

Inclusion criteria were:

• Normal liver and kidney function, no serious complications;

• Normal platelet count;

• Haemoglobin, haematocrit normal;

• Did not take anti-inflammatory drugs or stopped for half a month;

• The family members and the patients all signed the informed consent.

Exclusion criteria were:

• Abnormal liver and kidney function;

• Coagulation dysfunction;

• Long-term use of anti-inflammatory drugs did not stop the drug; (4) patients with mental abnormalities who cannot cooperate with the treatment.

This study was approved by the ethics committee of our hospital.

Methods

Intravenous midazolam (0.05 mg/kg), sufentanil (2.0~3.0 μg/kg), propofol (2.0~2.5 mg/kg) and vecuronium bromide (0.5~1.0 mg/kg) to anaesthesia induction, blood pressure, electrocardiogram and blood oxygen saturation were measured.

The self-platelet separation was performed with a Cell Saver 5 blood cell recovery machine from Haemonetics, USA. After successful induction, endotracheal intubation was performed, respiration was controlled, and respiratory parameters were adjusted according to end-of-breath concentration.

After endotracheal intubation, a 16 g central venous catheter was placed through the internal jugular vein using Haemonetics Cell Saver 5 to collect blood. The blood collection rate was 60 mL/min, and an anticoagulant was added at a rate of 2 drops/s. The separated platelet-rich plasma (PRP) was stored in a platelet-collecting bag and stored on a platelet shaker.

Observation indicators

Records were made of the operation time, the total amount of liquid infusion, intraoperative blood loss, amount of autologous blood transfusion, bleed-out, blood volume, urine volume, allogeneic blood transfusion, and the number of cases without allogeneic transfusion. Plasma fibrinogen degradation products (FDP), D-imer, and Granule Membrane Protein140 (GM-140) were determined by hemorheology detector. A blood gas analyser was used to detect the blood oxygen metabolism of the two groups of patients. The cardiac index (CI), oxygen supply (DO_2), oxygen consumption (VO2) and oxygen uptake rate (ERO_2) were also measured before platelet separation (F_1), after platelet separation (F_2), before autotransfusion (F_3), after autotransfusion(F_4), and 1 h after operation (F_5). Blood routine and coagulation function, platelet count, fibrinogen, prothrombin time and thrombin time were measured after anaesthesia induction.

Statistical methods

SPSS 21.0 software was used for statistical data analysis. Mean ± standard deviation ($\bar{x}\pm s$) was used to represent measurement data, t-test was used for inter-group comparison, [n (%)] was used for counting data, and χ^2 test was used for inter-group comparison, $p<.05$ was considered statistically significant.

Results

Comparison of surgical blood infusion volume

The amount of allogeneic blood infusion in the observation group was significantly lower than that in the control group, and the difference was statistically significant ($p<.05$). There was no statistically significant difference in other indicators between the two groups ($p>.05$). See Table 1.

Comparison of indicators of the fibrinolytic system between the two groups

Before treatment, FDP, D-Dimer and CM-140 in the two groups showed no statistically significant difference ($p>.05$), while FDP, D-Dimer and CM-140 in the two groups were significantly higher than

before treatment at each time point after surgery. The difference was significantly lower in the observation group than in the control group (p<.01). See Table 2.

Metric	Observation $n = 43$	Control $n = 43$	t/χ^2	p
Operation time (h)	3.12±0.61	3.16±0.49	0.335	0.738
Total liquid infusion volume (mL)	2621±486	2763±500	1.335	0.185
Intraoperative blood loss (mL)	962±349	958±352	0.052	0.957
Autotransfusion volume (mL)	423±142	401±124	0.765	0.446
Urine volume (ml)	548±239	512±159	0.822	0.413
Allogeneic blood infusion volume (mL)	492±321	661±312	2.475	0.015
The number of cases without allogeneic transfusion	6 (13.95)	8 (18.60)	0.341	0.559

Table 1: Comparison of Blood-saving Effect between the Two Groups ($\bar{x}\pm s$).

Index		Observation	Control	t	p
FDP (g/L)	Preoperative	22.42±5.61	23.62±2.64	1.269	0.207
	Postoperation 1 h	32.65±6.23*	47.23±5.69*	11.331	<0.001
	Postoperation 24 h	41.25±4.24*	50.65±7.84*	6.915	<0.001
D-Dimer (mg/L)	Preoperative	0.34±0.13	0.36±0.42	0.298	0.766
	Postoperation 1 h	0.86±0.17*	1.42±0.24*	12.485	<0.001
	Postoperation 24 h	0.81±0.16*	1.37±0.23*	13.106	<0.001
CM-140 (ng/L)	Preoperative	7.89±2.21	7.54±1.25	0.903	0.368
	Postoperation 1 h	18.47±4.21*	28.64±5.31*	15.797	<0.001
	Postoperation 24 h	16.23±2.12*	25.16±1.57*	22.197	<0.001

Table 2: Comparison of Indicators of the Postoperative Fibrinolytic System between the Two Groups (n=43, $\bar{x}\pm s$). *Note: Compared with the same group before treatment *p<.05.*

Comparison of blood oxygen metabolism

Compared with F1, DO2 at F3 decreased and ERO2 increased in the two groups, with a statistically significant difference (p<.05). There was no significant difference in other indexes between the two groups (p>.05). See Table 3.

Index	Group	F1	F2	F3	F4	F5
CI ($L\cdot min^{-1}\cdot m^{-2}$)	Observation	3.49±0.72	3.74±0.81	3.62±0.63	3.75±0.71	4.01±0.89
	Control	3.58±0.65	3.94±0.57	3.84±0.56	3.62±0.91	3.75±0.74
DO_2 ($ml\cdot min^{-1}\cdot m^{-2}$)	Observation	590±112	586±107	462±74*	572±74	584±121
	Control	602±123	606±124	469±64*	563±68	571±112
VO_2 ($ml\cdot min^{-1}\cdot m^{-2}$)	Observation	130±25	125±22	120±20	126±18	130±20
	Control	127±21	129±25	123±21	129±21	125±17
ERO_2 (%)	Observation	21.32±1.89	21.03±1.21	26.3 2.12*	21.06±1.79	22.31±2.65
	Control	21.21±2.21	21.65±2.11	26.21±1.85*	22.46±0.85	21.47±2.36

Table 3: Comparison of Blood Oxygen Metabolism Indexes between the Two Groups (n=43, $\bar{x}\pm s$). *Note: Compared with time point F1 of the same group, *p<.05.*

Platelet and coagulation function in the two groups

The platelet count, fibrinogen, prothrombin time and thrombin time of the two groups were significantly decreased at 1 h after the operation compared with that before the operation (p<.05), and the platelet count of the observation group was significantly higher than that of the control group at 1 h after the operation(p<.05).

There was no significant difference between the observation group and the control group at other time points (p>.05). See Table 4.

Index		Observation	Control
Platelet count(g/L)	Preoperative	190.65±36.52	175.65±49.36
	Postoperation 1 h	135.33±39.65*#	103.95±30.62*
	Postoperation 6 h	136.65±36.21*	122.28±26.22*
	Postoperation 24 h	149.65±43.27*	129.21±35.64*
Fibrinogen (μg/dL)	Preoperative	3.21±0.84	3.23±0.79
	Postoperation 1 h	2.13±1.42*	2.86±0.56*
	Postoperation 6 h	2.70±0.89	3.12±0.75
	Postoperation 24 h	3.42±1.43	2.86±0.83
Prothrombin time(s)	Preoperative	12.68±0.94	13.15±0.95
	Postoperation 1 h	13.69±1.31*	14.12±1.36*
	Postoperation 6 h	13.78±0.64	13.32±0.81
	Postoperation 24 h	13.96±1.29	13.17±0.38
Thrombin time(s)	Preoperative	34.61±7.52	30.42±3.28
	Postoperation 1 h	44.56±7.81*	43.21±9.58*
	Postoperation 6 h	35.65±7.92	34.36±6.78
	Postoperation 24 h	33.66±6.54	32.14±4.26

Table 4: Comparison of Haemoglobin Content and Coagulation Function between the Two Groups (n=43, $\bar{x}\pm s$). *Note: Compared with the same group before surgery, *p<.05; Compared with the control group after surgery 1 h, #p<.05.*

Discussion

Heart valve replacement is the replacement of an artificial biological valve or a mechanical valve. An artificial valve can easily lead to the formation of thrombosis, so patients must receive lifelong anticoagulation therapy[5]. There is a large amount of bleeding during heart valve replacement, which is difficult to stop. This can cause damage and reduction of platelets and clotting factors. In addition, platelet damage, reduction of coagulation factors and fibrinolytic system damage can lead to coagulation dysfunction after heart valve replacement[6, 7].

Platelet separation refers to the separation and extraction of partial platelets from the patient's blood before the operation. This is done to protect platelets from damage during the operation, ensure

that the patient's oxygen-carrying capacity and circulatory dynamics are stable, and they reduce the risk of platelet dysfunction[8]. Platelet separation can effectively protect the blood system during heart surgery, reduce the damage to the patient's own blood and reduce the infusion of allogeneic blood[9]. Studies have shown that compared with non-drug blood protection measures, platelet separation and reinfusion have a better effect on postoperative recovery of coagulation and reduction of bleeding[10]. The influence of platelet separation and reinfusion on cardiac surgery has been widely concerned in clinics, and it has become a hotspot of clinical research.

FDP is a fibrin decomposition product which is produced by the decomposition of fibrin and fibrinogen. It has the function of inhibiting platelet agglutination, inhibiting fibrin formation and antithrombin[11]. When the body fibre activity increased, the FDP level also increased. D-dimer is a fibrin degradation product[12]; it is generated by the hydrolysis of blood fibrin and it can reflect the fibrinolysis function. The higher the body's coagulation state, the higher the D-Dimer level[13]. GM-140 can reflect the degree of platelet activation and thrombogenesis, and it is a marker of platelet activation level. The higher the GM-140 level, the more serious the platelet destruction[14].

The results of this study showed that postoperative FDP, D-Dimer and CM-140 fibrinolytic system in the observation group were significantly lower than inf the control group. This indicates that platelet separation and reinfusion could improve the body's coagulation function and improve the body's FDP, D-Dimer and GM-140 levels so that the blood was diluted to a certain extent, blood viscosity decreased, and oxygen diffusion improved. Cardiac index CI, DO_2, VO_2 and ERO_2 can reflect whether the oxygen supply level of the body can maintain tissue oxygenation. The results of this study showed that DO_2, VO_2 and ERO_2 levels at time point F2 were not significantly different from those before surgery. This indicates that the platelet separation and extraction process had no effect on oxygenation of the body. At F3, DO_2 decreased and ERO_2 increased, indicating that the oxygen supply index LA level had increased. At time points F4 and F5, all indexes of the body returned to normal levels, indicating that platelet separation and reinfusion can improve the decline in the oxygen supply caused by ischemia of the body. Platelet count refers to the number of platelets contained in blood per unit volume. Platelets can release blood-clotting substances at the site of vascular rupture and promote blood clotting. Fibrin is a blood-clotting protein synthesized by the liver and a risk factor in the development of thrombosis. Prothrombin time refers to the conversion of prothrombin into thrombin, which leads to prolonged coagulation time. Thrombin can transform soluble fibrinogen into insoluble fibrin, which has the function of haemostasis and accelerated healing[15]. According to the results of this study, postoperative platelet count, agglutination function of the observation group was obviously higher than that of the control group. Bleeding in the observation group was significantly less than in the control group. In a part of the observation group, the coagulation function and fibrinolytic system recovered to preoperative levels, and the amount of allogeneic blood infusion in the observation group was significantly lower than that in the control group. This showed that platelet separation and reinfusion can decrease intraoperative blood loss and improve the function of platelet clotting.

Therefore, in heart valve replacement operations, platelet separation and reinfusion can protect the blood clotting system, reduce the importation of allogeneic blood, avoid postoperative bleeding, improve the platelet clotting function and the blood fibrinolysis system. This procedure is worthy of clinical promotion.

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