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Impact of Intraoperative Salvaged Blood Autotransfusion During Obstetric Hemorrhage on the Coagulation Function: A Retrospective Cohort Analysis

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Abstract

Objective: This study aimed to explore the effect of intraoperative blood salvage (autotransfusion) on coagulation function in the rescue of an obstetric hemorrhage.

Methods: A total of 65 pregnant women who were diagnosed with placenta previa in our Hospital and gave birth in the hospital were enrolled in the study. All the patients underwent thromboelastography, routine blood tests, and blood coagulation series + D-dimer before and within 30 min of the autologous blood transfusion. The differences in various indicators were evaluated.

Results: (1) After the autotransfusion, the hemoglobin and neutrophil counts were significantly higher than beforehand, and the platelet count was significantly reduced; the differences were statistically significant ($p < .05$). (2) There were no significant differences in prothrombin time (PT), fibrinogen, and D-dimer levels before and after the autotransfusion ($p > .05$). The activated partial thromboplastin time after autotransfusion was shorter than that beforehand, and the difference was statistically significant ($p < .05$). (3) There were no significant differences in the R value, K value, α value, and MA value of the thromboelastogram before and after the autotransfusion ($p > .05$).

Conclusion: After the recovery autotransfusion, the hemoglobin of patients with a massive obstetric hemorrhage increased significantly, while the platelet count decreased, but the coagulation function and thromboelastogram did not change significantly, indicating the autotransfusion did not affect the coagulation function of the obstetric hemorrhage rescue. Thus, it would appear that intraoperative blood salvage can be safely used in the clinical rescue of massive hemorrhaging during cesarean section.

Keywords

postpartum hemorrhage, coagulation function, autologous blood transfusion, blood salvage, placenta previa, cesarean section, safety

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Introduction

Obstetric medical technology has developed significantly in recent years, but postpartum hemorrhage remains the primary cause of maternal death. Furthermore, with the global development of the novel coronavirus epidemic, obstetric blood transfusions have become more difficult.

In 2013, the UK issued guidelines for intraoperative blood salvage,1 after which autotransfusion for obstetric surgery hemorrhaging gradually became more common in major hospitals in China. However, the correction of coagulation function is very important in the rescue of postpartum hemorrhage. In the present study, the data of patients who underwent blood salvage in the Obstetric Department of Taizhou Hospital, Zhejiang Province between 2015 and 2020 were analyzed to evaluate the effect of intraoperative autotransfusion on coagulation function in the rescue of obstetric hemorrhage.

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Patients and Methods

Subjects

Between January 2015 and June 2020, a total of 65 pregnant women underwent surgical delivery in Taizhou Hospital, Zhejiang Province. All 65 patients had placenta previa, and 63 had placental implantation. The average age was 34.5 ± 3.2 years, the average number of pregnancies was 3.7 ± 0.6, and the average number of deliveries was 2.1 ± 0.6.

Patients meeting the following criteria were excluded: (1) those with an estimated intraoperative blood loss ≥1000 ml; (2) those with other obstetric complications, such as gestational diabetes mellitus or gestational hypertension; (3) those with internal or external complications of important organs; (4) those who were rhesus negative; and (5) those suffering from systemic infectious diseases, such as influenza.

The use of salvaged blood autotransfusion technology during cesarean section was approved by the ethics committee of Taizhou Hospital, Zhejiang Province. The patients were informed in detail about the possibility of a blood autotransfusion for intraoperative hemorrhaging and about the possible risks. Informed consent was obtained from all the patients.

Methods

Preoperative Preparation. The peripheral vein and central venous access were opened, and the patient's vital signs were monitored. A single L2 to 3 epidural anesthesia was administered. In the event of hemodynamic instability during surgery, general anesthesia was performed immediately. Disposable surgical towels (7966, 3M) were laid in place as appropriate.

Blood Recovery. The process was performed by a trained anesthesiologist. A blood recovery device provided by Haemonetics (Braintree, USA) was connected to a 150-mmHg negative-pressure suction device, and anticoagulant liquid (1000 ml normal saline combined with 60,000 IU unfractionated heparin) was prepared. The anticoagulant suction double pipe was connected to the anticoagulant liquid and blood storage tank, which was pre-flushed with 150 to 200 ml anticoagulant liquid. When the salvaged blood volume was ≥800 ml, a centrifugal cup was installed, and the centrifugal washing procedure was initiated. The machine's default centrifugal speed and automatic cleaning mode were selected, and the washing volume of the 225 ml centrifugal cup was adjusted to 2000 ml normal saline. After washing, the machine automatically discharged the red blood cells into a blood bag and re-injected them through a white blood cell filter. The filter was replaced when 450 ml of the red blood cells had been washed.

Intraoperative Process. Two negative-pressure suction devices were used during the procedure: a common suction device was used to remove as much amniotic fluid as possible, while a blood recovery device was used after the placenta had been delivered. When the patient's hemoglobin fell below 70 g/L or the operation was over, the blood was infused and recovered. Before the autotransfusion, approximately 10 ml of venous blood was taken for a routine blood test, thromboelastogram, hemagglutination series, and D-dimer detection. Within 30 min of the blood salvage, the same amount of venous blood was taken again to recheck the relevant items.

Statistical Analysis

Data were analyzed using statistical software SPSS20.0. Tests of normality and homogeneity of variance in the measurement data were carried out first. Normally distributed measurement data with homogeneity of variance were expressed as mean ± standard deviation ($\bar{x}$ ± SD), and intergroup comparison was conducted using a paired sample *t*-test. Non-normally distributed measurement data were expressed as mean ± M (P_{25}, P_{75}), and intergroup comparison was conducted using the Wilcoxon rank sum test. Count data were expressed as a frequency, and $p < .05$ was considered statistically significant.

Results

Intraoperative Bleeding and Blood Transfusion

Average intraoperative blood loss was 1280 ± 350 ml, the volume of blood autotransfusion was 580 ± 120 ml, and the rate of blood autotransfusion was 100% (65/65). A total of 23 patients underwent secondary allogeneic blood transfusion, including allogeneic erythrocyte suspension (2.6 ± 1.25 u), plasma (325 ± 50 ml), platelets (2.2 ± 0.3 u), and cold precipitation (2.5 ± 0.5 u). No adverse reactions, such as fever, rash, pulmonary edema, bacteremia, or disseminated intravascular coagulation, were found in any patient who underwent the autologous blood transfusion alone, but a skin rash occurred in one patient who received a secondary allogeneic blood transfusion. No other transfusion complications occurred.

After the autotransfusion, the hemoglobin and neutrophil counts were significantly higher than beforehand, and the platelet count was significantly reduced; the differences were statistically significant ($p < .05$). The hematocrit and leukocyte counts after the autotransfusion were also lower, but the differences were not statistically significant (see Table 1).

Changes in the Thromboelastogram and Coagulation Function Before and After Blood Salvage

Activated partial thromboplastin time (APTT) after the autotransfusion was shorter than that beforehand, and the difference was statistically significant ($p < .05$). There were no significant differences in the R value, K value, α value, and MA value of the thromboelastogram before and after the autotransfusion ($p > .05$), and there were no significant differences in PT, fibrinogen (FIB), and D-dimer levels before and after the autotransfusion either ($p > .05$) (Tables 2 and 3).

Table 1. Changes of blood routine before and after transfusion of recovered blood

	WBC($\times 10^9$/L)	N (%)	Hb(g/L)	HCT(%)	PLT($\times 10^9$/L)
Before blood transfusion	16.5 ± 2.8	83.5 ± 8.5	7.5 ± 1.2	30.2 ± 3.8	164 ± 30.6
30 min after blood transfusion	15.7 ± 3.9	86.2 ± 5.9	9.7 ± 1.4	31.0 ± 2.2	151 ± 23.9
T value	1.33	−2.931	−10.37	−2.02	2.68
P value	.185	.005	<.001	.045	.008

Table 2. Effects of recovered blood on coagulation function and D-dimer before and after transfusion

	PT (s)	APTT (s)	FIB (mmol/L)	D-dimer (mg/L)
Before blood transfusion	12.2 ± 1.3	30.9 ± 2.3	3.72 ± 0.19	2.54 ± 0.73
30 min after blood transfusion	12.5 ± 1.9	29.5 ± 3.5	3.74 ± 0.12	2.37 ± 0.81
T value	−0.14	2.67	−0.71	1.26
P value	.299	.008	.478	.211

Table 3. Changes of thromboelastogram before and after transfusion of recovered blood

	R (min)	K (min)	A (deg)	MA (mm)	CI	LY30 (%)
Before blood transfusion	8.32 ± 1.2	2.81 ± 0.25	49.81 ± 2.8	47.9 ± 3.5	0.54 ± 0.16	27.30 ± 6.80
30 min after blood transfusion	8.30 ± 1.05	2.79 ± 0.29	49.70 ± 3.1	47.5 ± 3.15	0.55 ± 0.10	27.00 ± 6.20
T value	0.10	0.42	0.21	0.68	−0.427	0.43
P value	.920	.677	.833	.498	128.00	.667

Discussion

Despite the continuous development of obstetric medical technology in recent years, the number of high-risk pregnant women is considerable, and the incidence of postpartum hemorrhage remains high, meaning that it is still the primary cause of maternal death in China.2 The outbreak of COVID-19 has increased the risk and difficulty of allogeneic blood transfusion, and the potential complications, such as a viral infection or an immune response, have made autologous blood transfusion technology the focus of research3 in recent years. It is particularly important to correct the coagulation function in time in the rescue of obstetric hemorrhage, and therefore whether the intraoperative recycled autologous blood transfusion affects this function will determine the prospects for applying this technology in such an event.

In theory, a recycled autologous blood transfusion during surgery should not lead to abnormal coagulation function, but the timely correction of coagulation function in the rescue of obstetric hemorrhage determines the success or failure of the rescue. The main focus of this study was whether or not blood salvage during an operation affects the coagulation function of the patient. It is currently believed that sediment from the amniotic fluid entering the mother's blood can produce a waterfall-like systemic immune inflammatory reaction, after which a series of clinical manifestations, such as diffuse intravascular coagulation, severe hypoxemia, and multiple organ failure, may occur.[4,5] A previous study found that the combined use of autotransfusion and a leukocyte filter in obstetrics can almost completely remove small molecular substances, such as fetal squamous epithelium, amniotic fluid phosphatidylglycerol, tissue factor, free hemoglobin, and alpha fetoprotein, as well as other components similar to leukocytes in size, thereby avoiding the waterfall-like systemic immune inflammatory response.6–8 Waters *et al.*9 also reported on the presence of amniotic fluid components in the blood of healthy mothers and found that the concentration of amniotic fluid components in salvaged blood after treatment was much lower than that in the blood of healthy mothers.

Blood salvage appears to have other benefits. The average intraoperative blood loss was 1280 ± 350 ml, the volume of blood autotransfusion was 580 ± 120 ml, and the level of hemoglobin in the pregnant women increased from (7.5 ± 1.2) g to (9.7 ± 1.4) g, and the level of hematocrit increased from (30.2 ± 3.8) to (31.0 ± 2.0) ($p < .05$). This indicates that intraoperative blood salvage significantly reduces red blood cell loss, tissue hypoxia, and the need for a secondary allogeneic blood transfusion in patients with postpartum hemorrhaging. Sullivan *et al.*,10 retrospectively analyzed the application of salvaged blood autotransfusion in 1170 cases of cesarean section and the analysis conducted by Duan *et al.*[11,12] showed that blood salvage technology is a safe and effective clinical treatment for cesarean sections in women with placenta previa.

Obstetric patients with massive hemorrhaging lose a serious amount of blood, consume and lose a large amount of blood coagulation factors, and their blood is in a low coagulation state. In the process of intraoperative autologous blood collection, heparin needs to be added to prevent blood agglutination, which may aggravate the abnormal coagulation function of the body. In this study, the platelet count decreased from 164 ± 30.6 to 151 ± 23.9 after an autologous blood transfusion (p = .008). Although the levels of PT, FIB, and D-dimer in coagulation function fluctuated, there were no significant differences compared with those before the blood transfusion (p > .05). The thromboelastograms also showed there were no significant differences in the R value, K value, α value, and MA value before and after the autologous blood transfusion (p > .05), indicating that it did not increase the abnormality of coagulation function in the rescue of massive hemorrhage. He *et al.*13 found that in patients with acute massive bleeding during cesarean section, the application of IOCS will prolong APTT and reduce FIB levels. Adam *et al.*14 and other researchers also believe that compared with the concentration of the reservoir, the concentrations of FIB, coagulation factor II, coagulation factor VII, coagulation factor X, coagulation factor XIII, and all other measured coagulation factors in the washed erythrocyte concentrate are significantly reduced. In patients with large blood loss who need a sizeable red blood cell transfusion, the coagulation function may need correction. Among the 63 patients in this study, no cases of abnormal coagulation were found before and after the autologous blood transfusion. This needs further attention, especially for patients with large blood transfusions.

In this study, the APTT after the autotransfusion was shorter than that beforehand, and the difference was statistically significant (p < .05), but the thromboelastogram R value was prolonged. This difference may have been caused by the small sample size. There were no significant differences in the levels of the other coagulation function indicators, namely PT, D-dimer, and FIB, and the K value, α value, and MA value of the thromboelastogram (p > .05), suggesting that salvaged blood autotransfusion neither causes abnormal coagulation function nor improves it. It would therefore seem that to improve coagulation function after a red blood cell infusion, it is necessary to continue to infuse platelets, FIB, and cryoprecipitate.

The present study had some limitations. Since it was a retrospective study, although the selected patients were similar in baseline characteristics, selection bias could not be excluded. Therefore, it is necessary to carry out further multicenter clinical research with larger sample sizes to provide more evidence.

Conclusion

In summary, recycling autotransfusion technology is a safe and effective clinical treatment in the rescue of obstetric hemorrhage as it does not aggravate the abnormal blood coagulation after obstetric hemorrhage. However, neither does it improve it, and so, for patients with a large amount of bleeding and reinfusion, it is necessary to continue to infuse platelets, fibrinogen, and cryoprecipitate to improve coagulation function.

Declaration of Conflicting Interests

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Ethical Approval

This study was conducted with approval from the Ethics Committee of Taizhou Hospital of Zhejiang Province. This study was conducted in accordance with the declaration of Helsinki. Written informed consent was obtained from all participants.

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Supplemental Material

Supplemental material for this article is available online.

References

1. EXCELLENCE N I F H A C. Guidance for the provision of intraoperative cell salvage. 2013. https://www.nice.org.uk/guidance/ipg144.
2. Liu XH, Chen M. [Clinical treatment of postpartum hemorrhage based on big data]. *Chin J Pract Gynecol obstet*. 2018;34-(01):33-37. (In Chinese).
3. Zhou JC, Hu LH, Wang XF, et al. [Expert consensus on clinical pathway management of autologous blood transfusion (2019)]. *J clin hematol*. 2019;32(01):81-86. (In Chinese).
4. Haftel A, Chowdhury YS. Amniotic Fluid Embolism. 2021 Jul 26. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2021 Jan–. PMID: 32644533.
5. Sultan P, Seligman K, Carvakho B. Amniotic fluid embolism: update and review. *Curr Opin Anaesthesiol*. 2016;29(3):288-296.
6. Chen H, Tan H, Luo PX, et al. Comparison of cell salvage with one and two suction devices during cesarean section in patients with placenta previa and/or accrete: a randomized controlled trial. *Chin Med J (Engl)*. 2020;133(6):638-643.
7. Dai B, Wang L, Djaiani G, et al. Continuous and discontinuous cell-washing autotransfusion systems. *J Cardiothorac Vasc Anesth*. 2004;18(2):210-217.
8. Amand T, Pincemail J, Blaffart F, et al. Levels of inflammatory markers in the blood processed by autotransfusion devices during cardiac surgery associated with cardiopulmonary bypass circuit. *Perfusion*. 2002;17(2):117-123.
9. Waters J H, BiscottiI C, Potter P S, et al. Amniotic fluid removal during cell salvage in the cesarean section patient. *Anesthesiology*. 2000;92(6):1531-1536.
10. Sullivan IJ, Ralph CJ. Obstetric intra-operative cell salvage: a review of an established cell salvage service with 1170 re-infused cases. *Anaesthesia*. 2019;74(8):976-983.
11. Scott AV, Nagababu E, Johnson DJ, et al. 2,3-Diphosphoglycerate concentrations in autologous salvaged versus stored red blood cells and in surgical patients after transfusion. *Anesth Analg*. 2016;122(3):616-623.

12. Duan X, Chen DJ, Xu JF, et al. [Application of recovery autotransfusion technology in cesarean section of high-risk pregnant women with dangerous placenta previa]. *Chin J Maternchild Clin Med*. 2019;15(01):25-30. (In Chinese).
13. He HM, Cai HY, Gou DM. [Effect of autologous blood recovery combined with leukocyte filter on blood routine and biochemical indexes in patients undergoing cesarean section]. *Zun Yi Yi Xue Yuan Xue Bao*. 2017;40(06):660-664. (In Chinese).
14. Adam EH, Funke M, Zacharowski K, Meybohm P, Keller H, Weber CF. Impact of intraoperative cell salvage on blood coagulation factor concentrations in patients undergoing cardiac surgery. *Anesth Analg*. 2020 May;130(5):1389-1395.