Original Article
Comparative analysis of autologous blood transfusion and allogeneic blood transfusion in surgical patients

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Abstract: Objective: To investigate application effects of autologous blood transfusion and allogeneic blood transfusion in surgically treated patients receiving spine surgery, abdomen surgery and ectopic pregnancy surgery. Methods: 130 patients who would undergo selective operations were divided into autologous transfusion group and allogeneic transfusion group. Both groups received the same anesthesia, and there was no significant difference in transfusion volume or fluid infusion volume. Results: The serum TNF-α level in autologous transfusion group after operation showed a clear upward trend and had significant difference compared with that before operation (P < 0.05). Meanwhile, after operation, the serum TNF-α level in autologous transfusion group was all significantly higher than that allogeneic transfusion group and the comparative difference was statistically significant (P < 0.05). IgG level in treatment group did not significantly fluctuate during perioperative period, but IgG level in allogeneic transfusion group after operation was all significantly lower than that before operation, and there was statistically significant difference between both groups (P < 0.05). At the same time, complement C3 level in treatment group after operation was significantly higher than that before operation (P < 0.05), but complement C3 level in allogeneic transfusion group did not significantly change. After operation, there was statistically significant difference in complement C3 level between both groups (P < 0.05). Conclusion: Autologous transfusion is already a widely accepted transfusion method at present, and it can increase TNF-α and complement C3 levels in the body of surgically treated patients to strengthen immune ability against infection.

Keywords: Autologous blood transfusion, allogeneic blood transfusion, inflammatory factor, immune function, complement

Introduction

During surgical operation, a lot of patients need blood transfusion (transfusion is called for short) for protecting safety of operation. Meanwhile, transfusion is a commonly used treatment measure during perioperative period, but transfusion can cause a variety of adverse reactions, therefore, at present the issue about how to perform transfusion causes widespread concern [1, 2]. In traditional application, the used method is mainly emergency allogeneic transfusion, however, allogeneic transfusion can suppress immune function of tumor patients, causes relatively high postoperative infection rate, also prolongs hospital stay of patients, and can lead to death of patients under severe situation [3, 4]; mean-while, allogeneic transfusion may spread hepatitis viruses, human immunodeficiency virus, and also may cause immune transfusion reaction. Autologous transfusion refers to collection or recycling of the patient's own blood for re-transfusion during operation or after major blood loss; it can save 40%-50% of the blood resource and is clinically safe and reliable [5, 6]. At the same time, for some surgical patients complicated by internal medical disease, autologous transfusion can dilute blood to decrease viscosity so that body function was improved. Moreover, autologous transfusion is all re-transfusion in short term so that the blood is fresh, loss of the blood active ingredients is less, and the cells have good viability and strong action [7]. At present, studies have confirmed that IgG, TNF-α, complement and other relevant

Table 1. Comparison of basic data between both groups

Group	Cases (n)	Gender (male/female)	Age (years old)	BMI (kg/m²)	Spine operation/abdominal trauma/ectopic pregnancy	ASA grading (I/II)
Autologous transfusion	65	35/30	50.16 ± 2.14	23.24 ± 2.89	10/40/15	35/30
Allogeneic transfusion	65	34/31	50.36 ± 2.48	23.18 ± 3.00	12/38/15	36/29
t		0.098	0.385	0.154	0.085	0.109
P		> 0.05	> 0.05	> 0.05	> 0.05	> 0.05

inflammatory cytokines are anti-infection-related secretary immune effect molecules with immunity-enhancing action in the body, can exert anti-infection action by a variety of ways, are key cytokines starting anti-bacterial inflammatory responses and activate inflammatory cells thereby can facilitate the recovery of the patient who can obtain improved prognosis [8, 9]. Therefore, this paper has specially compared application effects of allogeneic transfusion and autologous transfusion in surgically treated patients and is reported as follows.

Materials and methods

Study subjects

From September 2011 to December 2013, 130 patients who would undergo selected operation in our hospital were selected and the inclusion criteria were: ASA grade I-II, spinal operation, thoracic and abdominal trauma, ectopic pregnancy patients; hemoglobin > 10^9/L; during operation, excessive bleeding (bleeding ≥ 2200 ml) needed transfusion; patients were informed and they agreed to coordinate. The exclusion criteria were: neoplastic diseases, acute and chronic infectious diseases, autoimmune diseases, metabolic diseases, respiratory diseases, liver and kidney diseases and serious cardiovascular and cerebrovascular diseases; viral or bacterial infections, fever, use of perioperative corticosteroids and other drugs affecting immune function. According to the principle of randomly drawing lots, patients were divided into autologous transfusion group and allogeneic transfusion group, including 65 patients each group, and there was no statistically significant difference in gender, age, body mass index (BMI), operation type and ASA grading between both groups (P > 0.05). See **Table 1**.

Transfusion methods

All patients received combined anesthesia, received the same induction way and drugs, and received basically the same type and total amount of drugs and fluid. After a patient was sent into the operating room, the patient was connected to a multi-parameter vital-sign monitor for monitoring vital signs, and the patient's blood sample was collected. Intraoperative fluid volume and infusion rate were strictly controlled so as to strive to be consistent and to maintain stable circulatory dynamics.

Autologous transfusion group: Since the incision began, an autologous blood recycling instrument, Haemonetics was used for recycling blood which had lost in the operating field, and the specific parameters were: speed of revolution was maintained at 5650 rev/min, the amount of saline for washing was 1000 ml, physiological saline containing heparin (12500 U/500 ml) was added at rate of 60 drops/min for anticoagulation, number of pumps of the roller was set at 300 ml/min, washing speed was 300 ml/min, and negative pressure for suction was 150 mmHg. Throughout the transfusion, the same blood recycling instrument was used. Then, through washing and centrifugation, all of the obtained concentrated red blood cells were all immediately re-transfused.

Allogeneic transfusion group: Banked blood samples were reasonably selected and blood in the operating field was not recycled. Suspended red blood cells were used for supplement according to 1/3 of the amount of bleeding.

During transfusion process, it should be ensured that under condition of the same blood loss volume in both groups, the amount of the transfused red blood cells had no difference.

Indicators

Intraoperative indicators: Operative time, intraoperative transfusion volume, fluid infusion volume, postoperative analgesic use, etc. in both groups were observed.

Determination of inflammatory cytokines: Before operation, on day 1 and on day 7 after

Table 2. Comparison of transfusion conditions between both groups ($\bar{x} \pm s$)

Group	Cases (n)	Operative time (h)	Intraoperative transfusion volume (ml)	Fluid infusion volume (ml)	Postoperative analgesia (ng/ml)
Autologous transfusion	65	3.56 ± 0.41	1250.9 ± 210.9	2000.6 ± 500.4	846.9 ± 6.5
Allogeneic transfusion	65	3.58 ± 0.48	1258.6 ± 248.0	2009.4 ± 410.8	850.6 ± 4.1
t		0.085	0.045	0.069	0.047
P		> 0.05	> 0.05	> 0.05	> 0.05

Table 3. Comparison of change of inflammatory cytokines between both groups at different time points (ng/ml, $\bar{x} \pm s$)

Group	Cases (n)	Before operation	Day 1 Postop.	Day 7 Postop.
Autologous transfusion	65	1.18 ± 0.24	1.32 ± 0.18*	1.51 ± 0.20*
Allogeneic transfusion	65	1.18 ± 0.21	1.20 ± 0.18	1.19 ± 0.17
t		0.098	3.683	16.257
P		> 0.05	< 0.05	< 0.05

Footnote: Postop: post operation; *: compared with before operation, t = 5.128, 18.963, P < 0.05.

operations, all patients' blood samples were collected for determining inflammatory cytokine TNF-α with radioimmunoassay. During sample collection, tubes with function of promoting coagulation were used to draw 10ml fasting venous blood; within 24 h after collection, the blood samples were centrifuged; after centrifugation at 3500 min at 10°C, the upper serum 2-3 ml was taken and was placed into a refrigerator at below -20°C for freezing so that these samples could be tested later.

Determination of immune indicators: Blood samples were collected with the same method at the same time; serum IgG level of the samples to be tested was determined with immune turbidimetric method and complement C3 level was determined with radioimmunoassay.

Statistical analysis

SPSS13.0 statistical software was used for analysis, and measurement data of all results in the paper were expressed as mean ± standard deviation ($\bar{x} \pm s$). Comparison was performed by intergroup t test and intragroup paired t test, and P < 0.05 was considered statistically significant.

Results

Comparison of transfusion conditions

All patients safely completed transfusion and there was no statistically significant difference in operative time, intraoperative transfusion volume, fluid infusion volume, postoperative analgesic dose between both groups (P > 0.05). See **Table 2**.

Comparison of change of inflammatory cytokines

Results found that serum TNF-α level in autologous transfusion group after operation showed a clearly upward trend and had significant difference compared with before operation (P < 0.05). Meanwhile, after operation, serum TNF-α level in autologous transfusion group was all significantly higher than allogeneic transfusion group and the comparison had statistically significant difference (P < 0.05). See **Table 3**.

Comparison of change of immune factors

Results found that IgG level in autologous transfusion group did not significantly fluctuate during perioperative period and IgG level in allogeneic transfusion group after operation was all significantly lower than before operation; intergroup comparison had statistically significant difference (P < 0.05). See **Table 4**. At the same time, complement C3 level in autologous transfusion group after operation was significantly higher than before operation (P < 0.05), but that in allogeneic transfusion group did not significantly change; after operation, there was statistically significant difference in complement C3 level between both groups (P < 0.05). Also see **Table 4**.

Table 4. Comparison of immune factors change between both groups at different time points ($\bar{x} \pm s$)

Group	Cases (n)	IgG (g/L)			C3 (ng/mL)		
		Before operation	Day 1 Postop.	Day 7 Postop.	Before operation	Day 1 Postop.	Day 7 Postop.
Autologous transfusion	65	12.64 ± 1.36	12.56 ± 1.23	12.58 ± 1.85	115.23 ± 18.52	131.65 ± 14.88	175.25 ± 18.47
Allogeneic transfusion	65	12.64 ± 2.18	12.38 ± 1.89*	12.37 ± 1.84*	116.00 ± 21.89	119.63 ± 18.44*	119.36 ± 17.08*
t		0.085	4.632	5.008	0.185	7.415	19.851
P		> 0.05	< 0.05	< 0.05	> 0.05	< 0.05	< 0.05

Footnotes: Postop.: post operation; *: Compared with before operation, t = 4.521, 5.105, 8.412, 20.552, P < 0.05.

Discussion

Operation often leads to acute blood loss, therefore, in order to correct the various adverse effects caused by bleeding, transfusion is often needed. Although skilled surgical technique can be used to shorten operative time and reduce intraoperative blood loss volume, the situation for needing transfusion is still relatively common and the demand for blood further increases [10]. However, with discovery of various types of hepatitis and HIV and other blood-borne diseases and concern for immune stress response, safety of allogeneic transfusion has been widely questioned. Although with advance in medical technology the safety of allogeneic transfusion has been very greatly improved compared with before, however, there have been still relatively many reports about adverse reactions, which are caused by transfusion of a lot of allogeneic blood, and infectious diseases appearing after transfusion [11, 12].

Application of autologous transfusion has over a century of history. It was initially applied for saving blood resource, and more importantly, it can reduce the unnecessary transfusion reactions and reduce spread of diseases caused by the banked blood. Moreover, it can effectively avoid errors and accidents of allogeneic transfusion, and also can avoid some of other adverse transfusion reactions, such as hemolytic reaction, allergic reaction, micro-thrombosis and toxic reaction [13, 14]. In this paper, all patients safely completed transfusion and there was no statistically significant difference in operative time, intraoperative transfusion volume, fluid infusion volume and postoperative analgesic dose between both groups (P > 0.05). Safety of autologous transfusion has also been further illustrated.

Inflammatory cytokines are important components of the body's immunity, and play an important role in postoperative resistance against infection, wound healing, anti-tumor, etc. At present, post-transfusion infection is relatively common; in the past, postoperative infection caused by transfusion was generally considered to be due to a variety of factors, but now it is considered to be mainly related to immune regulation of the body [15, 16]. Transfusion of allogeneic blood can produce phagocytosis and chemotaxis effect, leading to suppressing the immune function of patients and changing the patients' immune status so that the patients become susceptible to infection. Studies have shown that re-transfusion of autologous blood may exert inherent regulatory action on cellular immune function of the blood recipient. Under normal physiological condition, besides TNF-α exerts actions of immune enhancement and hematopoiesis promotion, it also can improve the body's non-specific immune function when inflammation exists. In the paper, the serum TNF-α level in autologous transfusion group after operation showed a clear upward trend and had significant difference compared with before operation (P < 0.05). Meanwhile, after operation, the serum TNF-α level in autologous transfusion group was all significantly higher than allogeneic transfusion group and the comparative difference was statistically significant (P < 0.05). Therefore, we hypothesized the reason was that the preparation needed for preservation of allogeneic red blood cells suppressed immunity and after long term storage of blood products, immunosuppressive factors would be generated. Autologous blood might contain small amount of inflammatory cytokines and autologous blood itself might have immune stimulating action, thus effect of alleviating immunosuppression or enhancing immune function was achieved.

Antibody and complement are also anti-infection-related secretory immune effect molecules with immune-enhancing action; among them,

IgG is main immunoglobulin which is generated during secondary immune response, and most anti-bacterial, anti-viral and anti-toxin antibodies belong to IgG. Complement C3 is anaphylatoxin and chemotactic factor and participates in the inflammatory and allergic reactions [17, 18]. In the paper, IgG level in autologous transfusion group did not significantly fluctuate during perioperative period, but IgG level in allogeneic transfusion group after operation was all significantly lower than before operation and there was statistically significant difference between both groups ($P < 0.05$). At the same time, complement C3 level in autologous transfusion group after operation was significantly higher than before operation ($P < 0.05$), but complement C3 level in allogeneic transfusion group did not significantly change; after operation, there was statistically significant difference in complement C3 level between both groups ($P < 0.05$). The possible mechanism was that the autologous transfusion was accompanied with leukocyte apoptosis, and after the body received re-transfusion of autologous blood, it activated T0 cells to differentiate into T1 cells, and T1 secreted large amount of TNF-α, which exerted positively regulatory effect on T1. At the same time, complement activation pathway was activated so that the complement C3 level increased, while the antibody changed slightly.

In conclusion, autologous transfusion is already a widely accepted transfusion method at present, and its application in surgically treated patients can increase TNF-α and complement C3 levels in the body thus the body's immune ability against infection is strengthened.

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Disclosure of conflict of interest

None.

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