Perioperative protocol to reduce blood transfusions in ankylosing spondylitis patients undergoing total hip arthroplasty

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Research article

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Astract

Introduction: Although tranexamic acid (TXA) can reduce bleeding during total hip arthroplasty (THA), the amount of perioperative bleeding is greater in patients with ankylosing spondylitis (AS); So blood management is more challenging. Patient Blood Management (PBM) program can improve AS patients care and reduce health costs in THA. The purpose of this study is to assess the effects of PMB program on allogeneic transfusion rate, length of hospital stay(LOS), hospitalization expenses and adverse events.

Methods: We conducted a retrospective observational study of patients with AS who underwent THA. All patients were treated with tranexamic acid before and after operation. Our PBM program included preoperative evaluation, preoperative acute normovolemic hemodilution and intraoperative recovery autotransfusion. We compared results between the group of patients before and the one after the PBM program implementation.

Result: We included 68 as patients who underwent total hip arthroplasty before PBM program from January 2013 to December 2015 (group A) and 84 as patients who underwent total hip arthroplasty after PBM program from January 2016 to December 2019 (group B). In the comparison of intraoperative blood transfusion volume, intraoperative blood transfusion rate and total blood transfusion rate between the two groups, the group B was significantly lower than the group A ($P \leq 0.05$); The length of stay and hospitalization expenses of the group B were lower than the group A ($P \leq 0.05$). No adverse events were recorded.

Conclunsions: Our PMB program can reduce allogeneic blood transfusion, hospital stay and hospitalization expenses, without risking patients to higher number of complications in AS patients undergoing THA.

Keywords

ankylosing spondylitis, total hip arthroplasty, patient blood management, acute normovolemic hemodilution, intraoperative recovery autotransfusion

Introduction The risk factors of bleeding included: male, bilateral total hip arthroplasty, hip range of motion = 0 °, increased ESR level, high preoperative hemoglobin level

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and long operation time for THA in AS patients with hip involvement[1]. Active as patients have an increased risk of bleeding due to coagulation, fibrinolytic system disorders and local inflammation[2]. It has been reported that there is a large amount of bleeding in total hip replacement for ankylosing spondylitis, including 1517ml ASB bleeding and 763ml ass bleeding; The intraoperative blood loss was 695.7 ± 285.7ml, and the allogeneic blood transfusion rate was 48.5%[3]. Compared with joint replacement for common diseases, the amount of perioperative bleeding in as is greater; Blood management is more challenging.

The rate of allogeneic blood transfusion in patients undergoing THA is between 10% and 32%, accompanied by complications such as infection, hemolytic blood transfusion reaction and prolonged hospital stay[4]. Hip hyperosteogeny is more serious in patients with AS, and more blood loss is caused by bone surface bleeding during operation[3]. TXA is a protective factor[1]; However, it still can not solve the problems of more intraoperative bleeding and high rate of allogeneic blood transfusion in as patients[2]. Some literatures show that independent strategies can not significantly reduce the incidence of allogeneic blood transfusion. It may be helpful to combine all useful methods and add some new strategies[5]. It is better to combine the blood protection program into a single strategy because it can avoid the risk of death in patients with functional anemia[6]. Allogeneic transfusion faces many complications; Blood safety remains a major problem. Therefore, in exploring alternative methods of allogeneic blood transfusion, autologous blood transfusion is one of the main means. Autotransfusion includes: 1. Storing autotransfusion; 2. Acute normovolemic hemodilution; 3. Recovery autotransfusion. The literature has proved that autologous blood transfusion can reduce blood loss and allogeneic blood transfusion in THA[7,8].

In January 2016, a PBM program was launched in our organization. The main objective was to determine the blood transfusion rate of patients with AS undergoing THA before and after PBM program. As a secondary objective, we reported the number of red blood cells infused before and after the protocol and recorded adverse events.

Materials and methods

Research design and setting

This retrospective study was conducted in the Department of orthopedics of the people's Hospital of Guangxi Zhuang Autonomous Region. Before the study, we carefully consulted the ethics committee and institutional review committee of Guangxi Provincial People's hospital. They believe that our PMB plan is a very mature treatment method in our hospital. This study is a retrospective comparative analysis and does not involve special intervention for patients. We should carry out this study in accordance with the declaration of Helsinki and provide patients with informed consent to let them know the use of data. This study was approved by the ethics committee and institutional review committee of the people's Hospital of Guangxi Zhuang Autonomous Region. Therefore, clinical research is carried out in accordance with the declaration of ethical principles of medical research involving the human body in Helsinki.

Participants and data sources

A retrospective cohort study was conducted in the Department of orthopedics of the people's Hospital of Guangxi Zhuang Autonomous Region, China. Patients with AS who underwent THA before PBM program implementation from January 2013 to December 2015 and after PBM program implementation from January 2016 to December 2019. The inclusion criteria:1. Unilateral total hip arthroplasty.2. Hemoglobin (HB) ≥ 100g / L. The exclusion criteria were: 1. Arrhythmia or angina pectoris. 2. Cerebral hemorrhage or vascular disease. 3. Thromboembolic disease or bleeding disorder. 4. Patients using anticoagulants and patients allergic to TXA. 5. Preoperative ultrasound examination of patients with thrombosis in affected limbs.

The general characteristics of patients, including age, weight, height, body mass index and operation time, were recorded; We recorded intraoperative and postoperative blood loss, occult bleeding, blood transfusion volume and blood transfusion rate, preoperative and postoperative hemoglobin, hemoglobin collection every other day after operation (1, 3, 5 days after operation and before discharge), complications (thromboembolic events Prosthetic or wound infection) and the total length of hospital stay and hospitalization expenses of the patient (the hospitalization expenses cannot be compared due to the different prostheses used by the patient, so the calculation of hospitalization expenses is to subtract the total hospitalization expenses from the expenses of prostheses).

Procedure

From January 2013 to December 2015, as patients with as total hip arthroplasty were given 2 doses of tranexamic acid before PBM program. All patients received intravenous tranexamic acid (20 mg / kg, IV) 15 minutes before operation; After the operation, tranexamic acid (20 mg / kg, IV) was injected intravenously.

Since the launch of the PBM program in January 2016, it has covered a number of different stages.1. Acute normovolemic hemodilution was evaluated by anesthesiologist after anesthesia; 15% - 20% of the blood volume of the whole body (blood volume, 70ml / kg for women and 75ml / kg for men) was extracted through the vein and stored in the ACD blood storage bag. At the same time, the same amount of plasma substitute or crystal solution (sodium lactate Ringer solution: 6% hydroxyethyl starch, 2:1) was injected through the peripheral vein; When Hg < 8g during operation or before the end of operation, autologous blood was reinfusion.2. All patients received intravenous tranexamic acid (20 mg / kg, IV) 15 minutes before operation; After the operation, tranexamic acid (20 mg / kg, IV) was injected intravenously.3. During the operation, the red blood cells in the operation field were collected by autologous blood transfusion system, washed and returned to the patient.4.

Blood gas was monitored by anesthesiologists during the operation, and hemoglobin (HB) and hematocrit (HCT) were measured by orthopedics doctors 1, 3 and 5 days after the operation. When Hg < 8g, homologous allogeneic blood was transfused.

Calculation of blood loss (CBL) and transfusion management

Calculation of blood loss. The patient’s blood volume (PBV) can be calculated using the formula of Nadler, Hidalgo and Bloch[9-11]:

PBV = kl x height (m)3+ k2 x weight (kg) + k3

where kl = 0.3669, k2 = 0.03219, k3 = 0.6041 for men;

kl = 0.3561, k2 = 0.03308, k3 = 0.1833 for women

Multiplying the PBV by the haematocrit will give the total red cell volume. Any change in red cell volume can therefore be calculated from the change in haematocrit Total red blood cell (RBC) volume loss = PBV x (Hct preop - Hct post-op)[12]

Intraoperative or postoperative transfusion rates were calculated by dividing by the total number of blood transfusions received during or after allografts. The overall transfusion rate was calculated by dividing by the total number of patients receiving treatment. The incidences of postoperative complications associated with the bleeding or thromboembolism were evaluated.

Statistical analysis

Statistical analyses were performed using SPSS 23.0 software. preoperative and Intraoperative and postoperative and RBCs transfused data were compared using independent Student's t-test between autologous blood transfusions and non-autologous blood transfusions groups. Categorical variables including transfusion rate was compared using the w2 test or Fisher's exact test. $p < 0.05$ was considered statistically significant.

Result

There was no significant difference in age, BMI, hemoglobin, hematocrit and coagulation function between the two groups (P ⩾ 0.05). (Table 1)

Table 1 preoperative data of two groups

Variables	Group A（n=68）	Group B（n=84）	P value
Age	36.1±8.7	38.6±10.2	0.111
BMI	21.9±2.7	22.6±2.3	0.087
Operation time (min)	91.8±17.9	98.5±19.4	0.075
Hematocrit (%)	31.85±6.24	33.05±4.65	0.266
Platelet(10^9/L)	230.1±32.8	227.6±28.4	0.615
Prothrombin time(s)	13.74±1.87	12.35±2.64	0.972
INR	0.94±0.12	0.99±0.15	0.070
D-dimer (μ g/mL)	1.05±0.93	1.17±0.85	0.497
APTT(S)	33.2±2.7	32.8±2.1	0.306

In the comparison of using group and No-using group, intraoperative blood transfusion volume (0.47±0.91vs2.07±1.71U), blood transfusion rate(25.0%vs48.5%), the total blood transfusion rate(32.1%vs60.2%) in the using group was significantly lower than that in the non-using group (P ⩽ 0.05);There was no significant difference in the volume of allogeneic blood transfusion and blood transfusion rate between the two groups after operation (P ⩾ 0.05); The total blood transfusion rate of patients in using group was lower than that in non-using group (P ⩽ 0.05), with statistical significance (see Table 2 Figure1,2).

able 2 Intraoperative and postoperative data of two groups

Variables	Group A （n=68）	Group B （n=84）	P value
Transfusion rate, n (%)			
Intraoperative	33(48.5%)	21(25.0%)	0.022
Postoperative	16(23.5%)	15(21.4%)	0.555
Overall	41(60.2%)	27(32.1%)	0.041

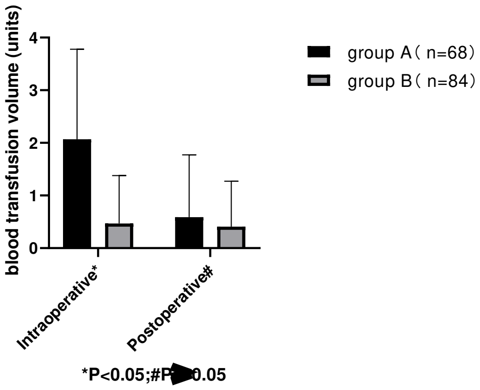

Figure1.Comparison results of the blood transfusion volume

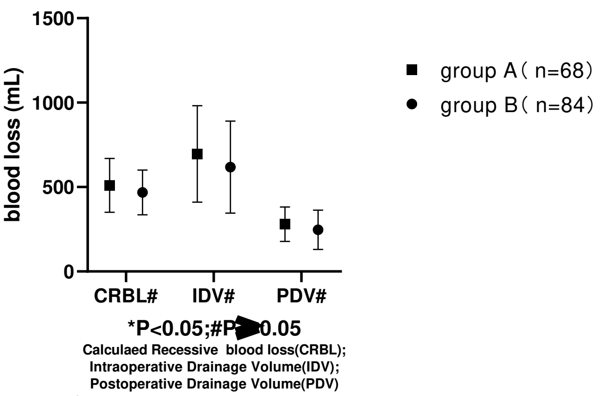

Figure2.Comparison results of theblood loss

There was no significant difference in operation time, blood loss, postoperative drainage, hidden blood loss, hemoglobin on D3, D5 and on discharge between the two groups (P ⩾ 0.05); On D1, the hemoglobin of the patients in the using group was significantly higher than that in the non-using group (P ⩽ 0.05) ; (see Figure3) The hospitalization days and hospitalization expenses of patients in using group were lower than those in non-using group (P ⩽ 0.05), with statistical significance (see Table 3).

able 3 Hospitalization days and Hospitalization expenses data of two groups

Variables	Group A （n=68）	Group B （n=84）	P value
hospitalization days（d）	9.28±1.8	7.34±1.7	0. 000
hospitalization expenses(￥)	30684.5±3251.8	25297.3±4759.2	0. 000

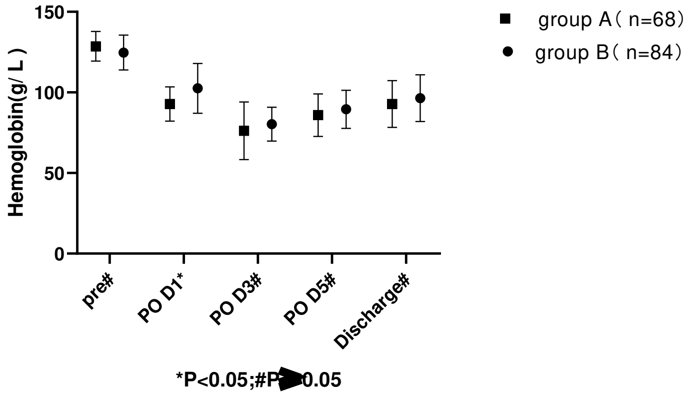

Figure3.Comparison results of the Hb

Discuss

Literature has proved that TXA can improve coagulation function, reduce blood loss and reduce allogeneic blood transfusion[13]; Therefore, it has become a common tool for perioperative blood management of THA. Because TXA can effectively prevent the degradation of coagulation function and achieve 90% renal clearance within 24 hours, It is the first choice in surgery[14]. TXA inhibits fibrinolysis by blocking the lysine binding site of plasminogen, thereby reducing the proteolytic activity of fibrin monomer and fibrinogen and reducing blood loss[15]. The action mechanism of TXA is to combine with plasminogen to prevent plasmin from degrading fibrin without increasing fibrin synthesis[16]. It can help reduce surgical trauma and tissue plasminogen activator release caused by bleeding and blood loss and reduce fibrinolysis[11]. The clinical effect of tax is good; It can effectively control intraoperative blood loss, alleviate the decrease of postoperative hemoglobin and reduce the demand for blood transfusion[15,17]. In hip surgery, intravenous and local tranexamic acid reduced the risk of blood transfusion by 60% to 70% compared with placebo[18]. It has been proved that tranexamic acid has a blood protective effect on as patients and total hip replacement patients[1,2]. But the use of tranexamic acid alone still has a high rate of blood loss and blood transfusion[3].the bone is osteoporotic due to disuse, and overreaming may compromise the acetabular bone stock[19]. Deliberate effort was made to leave a spike of bone at the superolateral acetabular margin[19]. The results of a large number of deformities and osteophytes in the operation will easily lead to blood loss[3]. In our study, it can also be confirmed that the use of tranexamic acid alone still has a high blood loss rate and blood transfusion rate.

The methods of blood management can be divided into three aspects: 1. Providing synthetic materials of red blood cells; The supply of erythropoietin or iron before and after the operation is the main method to provide red blood cell synthetic materials, which is conducive to the rapid generation of red blood cells; iron can improve the status of anemia and reduce the need for blood transfusion[20,21]; it also effectively corrected postoperative anemia caused by surgical bleeding[22]. 2. Reducing the loss of red blood cells; To reduce the loss of red blood cells is mainly to promote the coagulation function of patients to achieve the purpose of rapid hemostasis; there are hemostatic drugs and maintain the core temperature; TXA can not correct

Perioperative anemia[23,24],Iron can not correct anemia during operation; 3. Storing or reusing red blood cells; Storaging or reusing of red blood cells, which is also autotransfusion technology; It can reduce the loss of intraoperative red blood cells by the preoperative storage, intraoperative collection of red blood cells, and the stored red blood cells retransfusion to patients, so as to correct the anemia of patients and reduce the transfusion of allogeneic blood. Autologous blood transfusion technology combined with other methods is especially suitable for the operation with more bleeding.

Intraoperative autotransfusion is an established and safe technique in which blood from a bleeding patient is collected and reinfused into the same patient[3]. Intraoperative autotransfusion has been shown to reduce the need for allogeneic blood[25-27]. Autotransfusion is divided into storage transfusion, hemodilution and autologous blood recovery technology; Auto transfusion has its own advantages and limitations; Appropriate application of diluted autotransfusion can reduce intraoperative and perioperative blood loss, and reduce the use of allogeneic blood[28]. Similarly, the recovery of autologous blood transfusion can reduce intraoperative blood loss, perioperative blood loss, reduce the use of allogeneic blood[29]. A major advantage of simple Intraoperative auto transfusion, compared to allogeneic blood transfusion, is the reduced time until transfusion because there is no need for cross matching the blood[30]. For the patients with good self-condition, young, high blood pigment, and large intraoperative bleeding, we can use the combination of dilution and recovery autologous blood transfusion to further reduce the loss of intraoperative blood, and do not use or reduce the use of allogeneic blood. Concurrently, the pre-stored autologous blood contains platelets and coagulation factors, which is beneficial to reduce the postoperative drainage volume and hidden blood loss. For the patients with rare blood group blood matching difficulty or transfusion of allogeneic blood to produce immune antibody, the operation day can be appropriately delayed without affecting the operation, and the method of stored autologous blood transfusion can be adopted, and blood collection can be done once or in several times for pre-storage. During the operation, diluted or / and recovered autotransfusion were combined with other blood protection measures, in order to reduce the blood loss in operation and perioperative period to the greatest extent, to satisfy the requirements of perioperative blood management.

In our study, we found that the amount of allogeneic blood transfusion (0.47 ± 0.91) U and the number of blood transfusions in 21 (25.0%) patients in the B group were lower than those in the A group (2.07 ± 1.71) U and 33 (48.5%) respectively; Due to the use of autologous blood transfusion technology during the operation, the blood stored in ACD blood bag can be reinfused during the operation. The blood recovery technology can recover the lost red blood cells during the operation, and then return to the patients, so as to reduce the anemia state of patients and reduce the amount of allogeneic blood. Because of using autologous blood transfusion technology and allogeneic blood transfusion in patients with anemia, the hemoglobin level of patients in the B group after operation did not decrease significantly on the first day after operation; The decrease of hemoglobin in patients with the B group on the third day after operation was greater than that of patients with A group; The possible explanation is that the red blood cells washed by the auto recycling machine are prone to fragmentation after 24 hours, resulting in rapid reduction of hemoglobin. From the 5th day after operation, the hemoglobin level began to rise. It can be seen that PBM program can reduce allogeneic blood transfusion.

There are some limitations in our study. First, multicenter prospective studies may be more convincing. Second, grouping the patients according to the time period may lead to the deviation caused by the understanding of the disease and the maturity of the technology.

Conclusions: Our PMB program can reduce allogeneic blood transfusion, hospital stay and hospitalization expenses, without risking patients to higher number of complications in AS patients undergoing THA.

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Not applicable

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest withmrespect to the research, authorship, and/or publication of this article.

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Figures

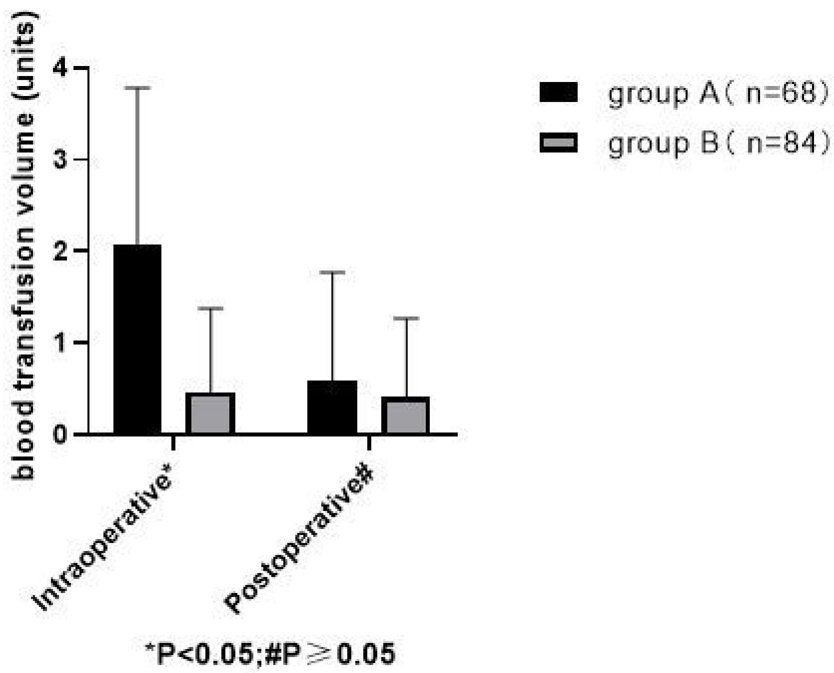

Figure 1

Comparison results of the blood transfusion volume

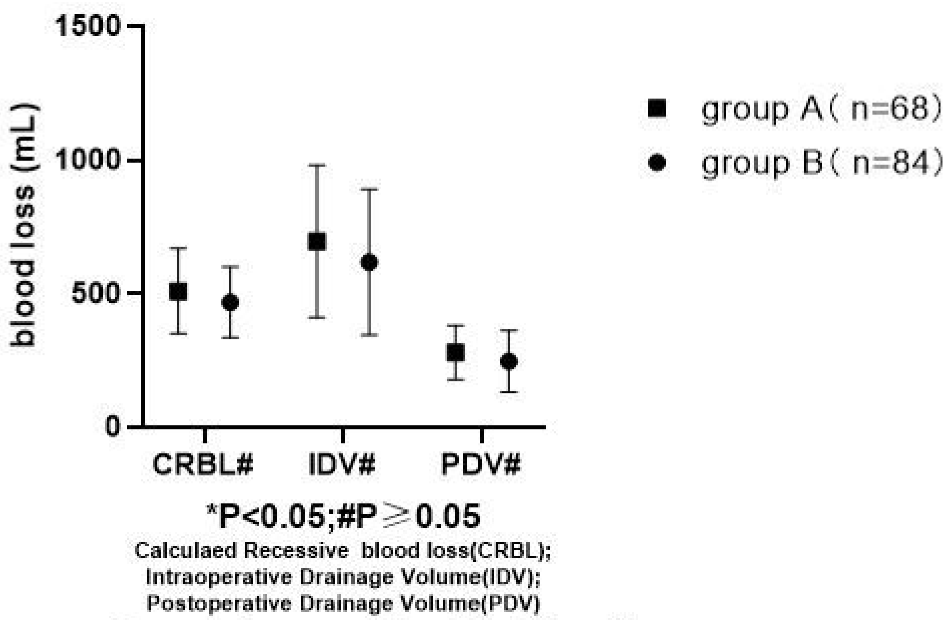

Figure 2

Comparison results of the blood loss

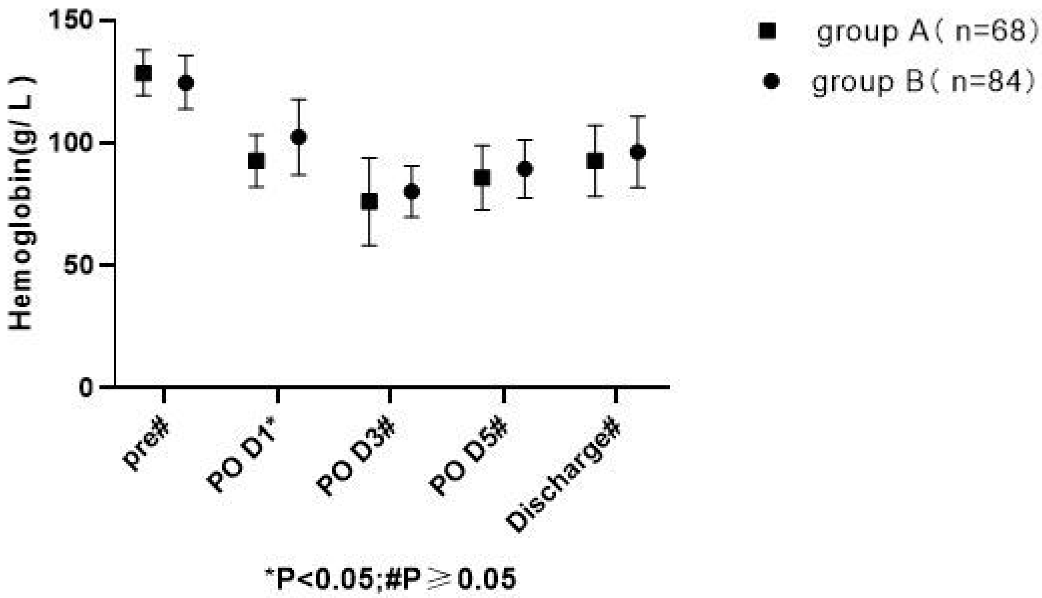

Figure 3

Comparison results of the Hb