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Allogeneic blood transfusion decreases with postoperative autotransfusion in hip and knee arthroplasty

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Objectives: We aimed to evaluate the effectiveness of postoperative autotransfusion method on prevention of the need of allogeneic blood transfusion in hip and knee arthroplasty.

Methods: Seventy-four patients who underwent 77 hip and knee arthroplasty operations were randomized into control and study groups, and evaluated prospectively. In the knee group (39 patients; 30 females, 9 males; mean age 66.6 years), cemented, cruciate retaining, and bicompartmental arthroplasty was performed under tourniquet control; whereas in the hip group (35 patients; 24 females, 11 males; mean age 59.3 years) cementless arthroplasty with posterolateral approach was performed. None of the patients received preoperative and intraoperative allogeneic blood transfusion. The collected blood in the surgical area was transfused with autotransfusion system to the patients in the study groups at the end of the fourth hour postoperatively. The mean amounts of autotransfused blood in hip and knee groups were 413 mL and 480 mL, respectively. Allogeneic blood transfusion was applied to the patients with hemoglobin level below 8 g/dL, hematocrit level below 25%, and clinical symptoms of anemia.

Results: Preoperative and postoperative hemoglobin-hematocrit levels did not differ significantly between study and control groups. Allogeneic blood transfusion was applied to one patient (5%) in study and 8 patients (38%) in control groups during knee arthroplasty (p=0.01); whereas 9 patients (53%) in study and 15 patients (79%) in control groups received allogeneic blood transfusion during hip arthroplasty (p=0.044). The amount of allogeneic blood transfusion in study groups was significantly lower than that in control groups (p=0.008 for knee arthroplasty, p=0.048 for hip arthroplasty).

Conclusion: The need and amount of allogeneic transfusion were reduced with postoperative autotransfusion in both knee and hip arthroplasty groups with greater extent in knee arthroplasty.

Key words: Allogeneic transfusion; arthroplasty; autotransfusion; hematocrit; hemoglobin; hip; knee.

Generally blood transfusion is needed intraoperatively and/or postoperatively to replace perioperative and postoperative blood loss in arthroplasty surgery due to hip and knee osteoarthritis.[1-5] About 500-2000 mL blood loss occurs in hip and knee joint arthroplasty depending on the surgical method, the type of anesthesia, and patient-related factors.[3,5-8] This amount is higher in revision surgeries.

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Allogeneic blood transfusion is usually the first choice to replace blood loss and to ensure the hemodynamic stability. However, this method is not out of problem. Allergic-immunologic reactions due to transfusion and infections particularly AIDS and hepatitis are feared complications of allogeneic blood transfusion.[1,9] Several methods have been developed to avoid these problems and to reduce transfusion requirement such as transfusion of the preoperative deposition of autologous blood to the patient after surgery, transfusion of the salvaged blood which is collected from the surgical area and processed with "cell saver" systems during surgery, and postoperative autotransfusion of the collected blood in the surgical area.[1] Postoperative autotransfusion method has been commonly used since the end of the 1970's, but lost its actuality in recent years. The number of prospective controlled studies about the effectiveness of the method is limited.

In our study, the effectiveness of postoperative autotransfusion method on the prevention of the need of allogeneic blood transfusion was evaluated in hip and knee arthroplasty.

Patients and methods

Between December 2008 and April 2009, 74 patients who underwent hip and knee arthroplasty operations (77 arthroplasty applications) were divided into control and study groups with the block randomization method, and evaluated prospectively. Inclusion criteria were first time arthroplasty because of hip and knee osteoarthritis and unilateral surgery. Patients operated simultaneous bilaterally, who had hematologic, chronic metabolic, infectious and/or rheumatologic diseases, with preoperative hemoglobin level below 12 g/dL, using anticoagulant therapy, with previous history of non-arthroplasty surgery in the same area, and planned revision hip and knee arthroplasty were excluded from the study. Patients were informed about the study, and written informed consents were obtained.

In the knee group (39 patients; 30 females, 9 males; mean age 66.6 years), cemented, cruciate retaining, bicompartmental arthroplasty was perfomed under tourniquet control; whereas in the hip group (35 patients; 24 females, 11 males; mean age 59.3 years) cementless arthroplasty with posterolateral approach was perfomed. All surgeries were performed by the same orthopedic surgeon. The period between two surgeries in bilateral cases was 4 months in the knee group (2 patients) and 3 months in the hip group (1 patient). None of the patients were received blood transfusion during the surgery. Postoperative protocols of infection and deep vein thrombosis prophylaxis were the same in the hip and knee groups. Antibiotic prophylaxis was started 30 min before the skin incision with 1 g first-generation cephalosporin (cefazolin) intravenously, and continued for 48 hours as three times a day. Subcutaneous low molecular weight heparin with adjusted dose according to the weight was used for deep vein thrombosis prophylaxis in all patients, and continued for 10 days.

The autotransfusion set (Transolog, Heim Medizintechnik, Germany) was placed into the surgical area for patients in the study groups at the end of the operation. The used set was a system which could collect approximetly 1000 mL of blood in a 240 microns filter bag with low negative pressure, and transfuse it to the patient with a 40 microns filter bag (Fig. 1). The collected blood in the system was transfused at the end of the fourth hour postoperatively. No anticoagulant was included in the system in any patient. The system was routinely used as hemovac drain after transfusion, and removed from the surgical area at the end of 48th hour. Routine hemovac drain was used postoperatively for patients in the control groups for 48 hours.

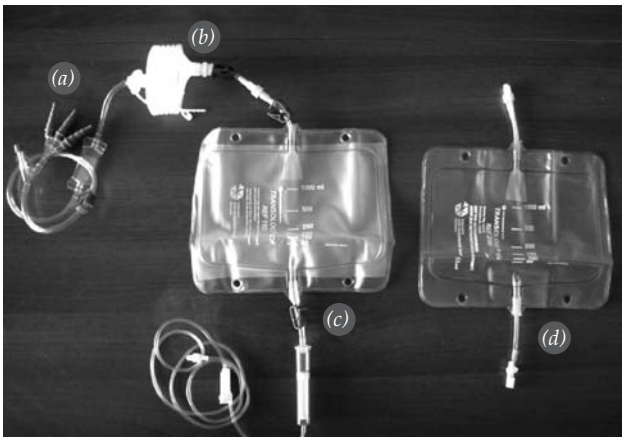

Fig. 1. Autotransfusion set used in the study. **(a)** The universal adaptor which is connected with wound drains placed in the surgical field, **(b)** vacuum collecting blood with negative pressure, **(c)** 240 microns filtration bag, **(d)** drainage bag which collects blood from the surgical field after autotransfusion.

Hemoglobin and hematocrit levels were measured in all patients before and immediately after the operation; on the first, third and fifth postoperative days, and at the end of the first week. The amounts of autotransfusion in the study groups were recorded. The number of patients who need allogeneic blood transfusion and the amounts of allogeneic transfusion were determined in both groups. Allogeneic transfusion was applied to the patients who had hemoglobin level below 8 g/dL, hematocrit level below 25% and clinical signs of anemia (tachicaridia, hypotension, dyspnea, etc.). All patients during the autotransfusion and/or allogeneic transfusion were followed up by monitoring in terms of dizziness, tachycardia, postural hypotension, angina pectoris, myocardial infarction, and anaphylactic reactions. Reactions due to transfusion were recorded.

NCSS 2007 software package (NCSS Statistical Software, Kaysville, UT, USA) was used for statistical evaluation. Apart from descriptive statistical methods such as mean and standard deviation; Friedman test was used to compare the repeated measurements within the groups, Mann-Whitney U test was used to compare the study groups for quantitative variables and chi-square test for qualitative variables. A p value of <0.05 was considered to be statistically significant.

Results

There was no statistically significant difference between study and control groups in hip and knee arthroplasty in terms of age, gender, and preoperative hemoglobin and hematocrit levels (Tables 1-3). The mean amount of autotranfusion was 480 mL (range 250-800 mL) in the knee group and 413 mL (range 200-800 mL) in the hip group.

The lowest postoperative hemoglobin and hematocrit levels in both surgical groups were recorded in the third postoperative day; however there was not statistically significant difference between study and control groups in hip and knee arthroplasty in terms of the control hemoglobin and hematocrit levels (Tables 2 and 3).

Only one patient (5%) had allogeneic transfusion requirement in the knee study group, whereas 8 patients (38%) received allogeneic transfusion in the

Table 1

Comparison of patients in knee and hip groups with regards to age and gender [mean±SD or n (%)]

		Knee group		
		Study group	Control group	Test statistics p value
Age (years)		65.25±12.57	68.19±6.62	MW: 174.5 p=0.353
Gender	Female	18 (90%)	14 (66.7%)	χ^2: 3.25 p=0.071
	Male	2 (10%)	7 (33.3%)	
		Hip group		
		Study group	Control group	Test statistics p value
Age (years)		59.76±15.43	58.95±13.6	MW: 152 p=0.753
Gender	Female	11 (64.7%)	13 (68.4%)	χ^2: 0.05 p=0.813
	Male	6 (35.3%)	6 (31.6%)	

χ^2: Chi-square test, MW: Mann-Whitney U test.

Table 2
Comparison of hemoglobin and hematocrit levels in patients with knee arthroplasty in study and control groups (mean±SD)

	Study group	Control group	MW	p value
Hemoglobin (g/dL)				
Preoperative	13.05±1.05	13.06±2.17	208.5	0.969
Postoperative	11±1.33	10.97±1.86	201.5	0.824
Postoperative 1st day	10.66±1.5	10.32±1.99	168	0.273
Postoperative 3rd day	9.72±1.16	9.37±2.04	156.5	0.163
Postoperative 5th day	9.77±1.04	9.42±1.6	161.5	0.205
Postoperative 1st week	10.1±0.93	9.91±1.27	180.5	0.441
Hematocrit (%)				
Preoperative	39.07±2.91	39.94±6.41	187	0.549
Postoperative	32.59±3.68	33.52±5.98	191.5	0.629
Postoperative 1st day	31.32±3.84	31.94±5.95	200.5	0.804
Postoperative 3rd day	28.93±2.94	28.72±6.15	172	0.321
Postoperative 5th day	28.38±5.34	28.68±4.29	197.5	0.744
Postoperative 1st week	29.98±2.95	29.75±3.3	199	0.774

MW: Mann-Whitney U test.

knee control group (p=0.01). The amount of allogeneic transfusion in the study group was statistically lower than the control group (p=0.008) (Table 4). In the hip group, allogeneic transfusion was performed to 9 patients (53%) in the study group and 15 patients (79%) in the control group (p=0.044). The amount of allogeneic transfusion in the study group was statistically lower than the control group (p=0.048) (Table 4).

No complications related to autotransfusion were recorded in the study groups. Febril reaction due to allogeneic transfusion occured in three of the patients in the control groups (one patient in the knee group, two patients in the hip group), and transfusion was discontinued.

Discussion

Significant amount of bleeding during and/or after surgery can occur in total hip and knee arthroplasty applications which can affect the hemodynamic stability of the patients. Preoperative hemoglobin and hematocrit levels, gender, age, physical condition of the patient, the existing internal diseases, body mass index, the levels of coagulation factors, the types of anesthesia and surgery are important factors in determining the amount of blood loss during surgery and the need of perioperative and/or postoperative blood transfusion.[6,10] Allogeneic transfusion requirement has been reported to be three times more in cases with preoperative hemoglobin level under 12 g/dL.[10] Therefore, patients with hemoglobin level over 12 g/dL were included to our study for the evaluation of effectiveness of autotransfusion method.

Except visible blood loss during surgery and estimated blood loss, which can be viewed from the drain after surgery; blood loss may occur much more than estimated because of hidden bleeding into the tissues. In a prospective study of 3,996 patients from 225 centers, it was reported that the average estimated blood loss was 750 mL and actual computed blood loss was 1994 mL in hip arthroplasty; whereas the average estimated blood loss was 800 mL and actual computed blood loss was 1934 ml in knee arthroplasty.[11] To replace this blood loss, the first choice is still allogeneic blood transfusion. There are different opinions in orthopedic surgery about the targeted hemoglobin and hematocrit values during patient's discharge. Despite differences in application between countries

Table 3
Comparison of hemoglobin and hematocrit levels in patients with hip arthroplasty in study and control groups (mean±SD)

	Study group	Control group	MW	p value
Hemoglobin (g/dL)				
Preoperative	13.52±1.07	12.98±1.46	117	0.118
Postoperative	10.46±1.35	10.33±1.25	149.5	0.703
Postoperative 1st day	9.84±1.2	9.58±1.06	152.5	0.775
Postoperative 3rd day	9.3±1.03	9.06±0.89	145	0.601
Postoperative 5th day	9.6±0.97	9.11±1.36	113	0.124
Postoperative 1st week	10.01±1.15	9.59±1.22	120.5	0.194
Hematocrit (%)				
Preoperative	38.92±3.25	37.55±3.74	120	0.188
Postoperative	30.09±4.14	31.34±4.38	125.5	0.254
Postoperative 1st day	28.51±3.73	29.14±3.71	140	0.496
Postoperative 3rd day	27.04±3.54	27.1±2.83	155	0.837
Postoperative 5th day	28.03±2.58	27.55±4.42	138.5	0.466
Postoperative 1st week	29.23±3.36	29.47±3.22	156.5	0.874

MW: Mann-Whitney U test.

and hospitals, some authors advise that the targeted hematocrit should be between 31-35% in the knee and hip surgeries, and tranfusion should be done according to these level;[9] on the other hand, the others argue that hemoglobin level between 7-9 g/dL is enough for patients younger than 55 years without systemic disease.[12-15] In our study, allogeneic transfusion was perfomed to the patients with hemoglobin level under 8 g/dL in both groups.

Helm et al.[7] evaluated allogeneic blood transfusion requirements in 79 patients undergoing total hip and knee arthroplasty, and reported that 66% of patients (58% of knees, 73% of hips) had at least one unit of blood transfused postoperatively, with a mean transfusion requirement of 1.3 units per patient. Bilgen and Yılmaz[8] reported that 47-100% of patients required blood transfusions after total knee arthroplasty and the average amount of required blood transfusion ranged from 1.8 to 2.7 units for unilateral knee arthroplasty. In our study, allogeneic blood transfusion requirements in patients in knee and hip control groups were 38% (0.71±0.96 units) and 79% (1.68±1.44 units), respectively.

Allogeneic blood transfusion and replacing blood volume deficit are associated with a number of complications such as prolonged hospital stay and increased costs.[1,4,5,9] To avoid these disadvantages, using the patient's own blood had become current approach in major orthopedic surgery, and the number of related studies had increased in the past 20 years.

It was reported that deposition of the patient's own blood preoperatively and then autotransfusion during surgery was the method which created the greatest reduction in allogeneic blood transfusion.[4,16] In addition, it was also shown that this method was successful in the prevention of risks related to allogeneic blood transfusion.[3] However the majority of patients undergoing joint replacement surgery are elderly and anemic; therefore preoperative deposition of sufficient quality blood to satisfy their requirements during surgery may not be always possible.[3,17] Otherwise, deposited autologous blood for elective surgery reduces the need for allogenic blood transfusion.[1]

Successful results were reported with autologous transfusion using "cell saver" systems during surgery; but it was also stated that these systems were expensive and had limited availability.[4,16,18]

Postoperative autotransfusion is another method which can be used as an alternative to allogeneic blood transfusion. Several studies showed that postoperative autotransfusion reduces the need for allogeneic blood transfusion.[1,3,5,19,20] Ayers et al.[20] reported that this method decreases the need of transfusion especially in patients for whom preoperative autologous blood deposition is not available. In a prospective, randomised, controlled study on 70 patients having unilateral knee arthroplasty, 86% reduction of the need for allogeneic transfusion was achieved with postoperative autotransfusion method, and it was concluded that autotransfusion in unilateral applications is a reliable, effective, and inexpensive method.[5] In a prospective, randomised, controlled study on 109 patients who underwent hip and knee arthroplasty, Slagis et al.[3] reported that autotransfusion method did not significantly reduce the need of allogeneic transfusion in comparison with the unilateral hip and knee arthroplasty control groups; however there was a 58% reduction in the need of allogeneic transfusion in patients undergoing bilateral knee arthroplasty. It was stated that in patients who had allogeneic transfusion requirement of two or more units, autotransfusion was a cheaper method and reduced duration of hospital stay, and febrile and infective problems. In our study, allogeneic transfusion requirement was reduced 33% in the knee and 26% in the hip study groups, in which aututransfusion set was used, compared with the control groups. In addition, there was a statistically significant decrease in the amount of allogeneic transfusion in the study groups.

However, there are some negative aspects of autotransfusion method. Some problems reported in the literature were vasovagal and anginal attacks, tetany, compartment syndrome, bacterial contamination, nonhemolytic febrile and septic reactions, phlebitis and vascular damage.[1] To avoid these problems, using the cell washing systems with autotransfusion has been suggested. Slagis et al.[3] routinely used cell washing system in the autotransfusion method; however, Newman et al.[5] concluded that using of washing system was expensive and unnecessary. Except the filter system in the autotransfusion set, we did not use any washing system for autotransfusion in our study. None of the patients in the study group encountered febrile and allergic reactions.

Table 4

Comparison of patients in the knee and hip groups with regards to allogeneic blood transfusion requirement and amount of blood transfused [mean±SD or number of surgical applications (%)]

		Knee group		
		Study group	Control group	Test statistics p value
Allogeneic blood transfusion	No	19 (95%)	13 (62%)	χ^2: 6.55
	Yes	1 (5%)	8 (38%)	p=0.01
Amount of transfusion (Unit)		0.05±0.22	0.71±0.96	MW: 137 p=0.008
		Hip group		
		Study group	Control group	Test statistics p value
Allogeneic transfusion	No	8 (47%)	4 (21%)	χ^2: 4.02
	Yes	9 (53%)	15 (79%)	p=0.044
Amount of transfusion (Unit)		0.82±1.07	1.68±1.44	MW: 99.5 p=0.048

χ^2: Chi-square test, MW: Mann-Whitney U test.

Approximately 80% of bleeding after hip and knee arthroplasty occurs within the first 4 hours postoperatively.[3,21] Transfusion of the collected blood within 4 hours may replace the blood deficit substantially in autotransfusion method. The effectiveness of autotransfusion method in hip and knee groups was found to be different in our study. The main reason of this difference is performing the knee arthroplasty under tourniquet control, and thus the absence of blood loss during surgery and replacing the large portion of the blood loss with autotransfusion postoperatively.

In our study, the reduction in the need of allogeneic blood transfusion was achieved with postoperative autotransfusion method in both knee and hip arthroplasty groups with greater extent in knee arthroplasty. Therefore, autotransfusion method is very reliable in unilateral knee arthroplasty. However, allogeneic blood should be prepared for transfusion in hip arthroplasty, even if autotransfusion is used.

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