



Autologous blood transfusion in total knee replacement surgery

Primena autologne transfuzije krvi kod ugradnje totalne proteze kolena

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Abstract

Background/Aim. Total knee replacement (TKR) surgery is one of the most frequent and the most extensive procedures in orthopedic surgery, accompanied with some serious complications. Perioperative blood loss is one of the most serious losses, so it is vital to recognize and treat such losses properly. Autologous blood transfusion is the only true alternative for the allogeneic blood. The aim of this study was to examine if autologous blood transfusion reduces usage of allogenic blood in total knee replacement surgery, as well as to examine possible effect of autologous blood transfusion on postoperative complications, recovery and hospital stay of patients after total knee replacement surgery. **Methods.** During the controlled, prospective, randomised study we compared two groups of patients ($n = 112$) with total prosthesis implanted in their knee. The group I consisted of the patients who received the transfusion of other people's (allogeneic) blood ($n = 57$) and the group II of the patients whose blood was collected postoperatively and then given them [their own (autologous) blood] ($n = 55$). The transfusion trigger for both groups was hemoglobin level of 85 g/L. **Results.** In the group of patients whose blood was collected perioperatively only 9 (0.9%) of the patients received transfusion of allogeneic blood, as opposed to the control group in which 98.24% of the patients received the transfusion of allogeneic blood ($p \leq 0.01$). The patients whose blood was collected stayed in hospital for 6.18 days, while the patients of the control group stayed 7.67 days ($p < 0.01$). **Conclusion.** Autologous blood transfusion is a very effective method for reducing consumption of allogenic blood and thus, indirectly for reducing all complications related to allogenic blood transfusion. There is also a positive influence on postoperative recovery after total knee replacement surgery due to the reduction of hospital stay, and indirectly on the reduction of hospital costs.

Key words:

blood transfusion, autologous; blood transfusion; arthroplasty, replacement, knee; orthopedic procedures.

Apstrakt

Uvod/Cilj. Operacija ugradnje totalne proteze kolena spada u jednu od najčešćih i najekstenzivnijih intervencija u ortopedskoj hirurgiji i udružena je sa brojnim komplikacijama. Perioperativni gubitak krvi je jedna od najozbiljnijih komplikacija te ga je neophodno na vreme prepoznati i adekvatno tretirati. Jedina prava alternativa za transfuziju alogene krvi (tuđe krvi, krvi dobijene od dobrovoljnih davalaca) je transfuzija autologne (svoje) krvi. Studija je primarno imala za cilj da ispita da li i koliko primena autologne krvi utiče na redukciju primene alogene krvi kod operacija zamene totalne proteze kolena. Sekundarni ciljevi su bili uticaj autologne transfuzije na perioperativne komplikacije, postoperativni oporavak bolesnika i broj dana koji bolesnik provede u bolnici. **Matode.** Tokom kontrolisane, prospektivne, randomizovane studije upoređivali smo dve grupe bolesnika kod kojih je operativnim putem ugrađivana totalna proteza kolena, ukupno 112 bolesnika. Grupu I činili su bolesnici koji su dobijali transfuziju tuđe (alogene) krvi ($n = 57$), a grupu II bolesnici kod kojih je postoperativno prikupljena njihova (autologna) krv ($n = 55$). Transfuziji krvi smo u obe grupe pristupali pri vrednosti hemoglobina od 85 g/L. **Rezultati.** U grupi bolesnika kod kojih se perioperativno prikupljala krv (autologna transfuzija) samo 9,09% je dobilo transfuziju alogene krvi, za razliku od kontrolne grupe u kojoj je 98,24% dobilo transfuziju alogene krvi ($p \leq 0,01$). Broj dana provedenih u bolnici kod grupe bolesnika kod kojih je prikupljana sopstvena krv bio je 6,18, a kod kontrolne grupe 7,67 dana ($p < 0,01$). **Zaključak.** Autologna transfuzija je efikasan način smanjenja upotrebe alogene krvi. Njenom primenom se redukuje pojava potencijalnih komplikacija vezanih za primenu alogene krvi, ima pozitivan uticaj na postoperativni oporavak bolesnika, smanjuje broj dana koje bolesnik provede u bolnici i na, indirektan način, smanjuje ukupne troškove lečenja bolesnika koji se podvrgavaju operaciji ugradnje totalne proteze kolena.

Ključne reči:

autotransfuzija; transfuzija krvi; artroplastika kolena; ortopedske procedure.

Introduction

Total knee replacement (TKR) surgery is one of the most frequent and the most extensive procedures in orthopedic surgery, accompanied with some serious complications. Perioperative blood loss is one of the most serious losses, so it is vital to recognize and treat it properly. Timely and precise treatment of perioperative blood losses has an impact on the outcome of the surgery and the quality of postoperative recovery. Transfusion of allogeneic blood carries certain risks, such as allergic reactions, anaphylaxis, hemolytic reactions, transmissible diseases, transfusion related lung injury (TRALI), graft-versus-host disease, etc.¹⁻⁵. In the past few decades, a lot of effort has been made to find a solution to the problems connected with allogeneic transfusion. One of the alternatives is autologous blood transfusion, which is widely accepted as probably the only true alternative for allogeneic blood. The justification for the use of this alternative method could be found in a certain level of morbidity and mortality which accompanies allogeneic blood transfusions^{6,7}.

The autologous blood transfusion is a collection and reinfusion (transfusion) of the patient's own blood or blood components before, during or after surgical procedure. So, the donor and recipient of blood is the same person. Although not completely risk-free, autologous blood is the safest blood donation.

According to the American Association of Blood Banks the most important strategies for blood donation are: preoperative autologous donation, acute normovolemic hemodilution, and perioperative blood salvation.

Perioperative blood salvage is intraoperative collection by aspiration from the operative fields and postoperative collection of blood from wound drains^{8,9}.

Autologous transfusion is indicated in certain surgeries when major blood losses are expected. The prerequisite for this procedure is no wound or systematic infection and normal hemoglobin levels in patient's blood.

Total knee replacement surgery is one of the most serious operations in orthopedic surgery. Frequently accompanied with serious intraoperative and postoperative bleeding, it is usually performed with pneumatic tourniquet, so autologous blood salvation takes place from wound drains in the postoperative period.

The aim of the study was to improve our everyday clinical practice, to contribute to better understanding of perioperative blood loss and its treatment in TKR surgery, and thus to affect the outcome of the surgery in a positive way.

Methods

This single-center (Clinic for Orthopaedic Surgery and Traumatology, Clinical Centre of Vojvodina, Novi Sad), prospective, randomised, controlled study included 112 patients undergoing TKR surgery in a 3-months period during 2010. The patients were randomly divided in two treatment groups, the group I (n = 57) receiving allogeneic blood, and the group II (n = 55) receiving autologous blood.

The transfusion trigger for the group that received allogeneic blood was 85 g/L. We chose this value for the hemoglobin trigger because the majority of our patients were elderly people, usually with comorbidities. For the group that received autologous (their own) transfusion, blood was collected from wound drains postoperatively within 4 h. The minimal amount of drained blood was ≥ 200 mL for the process to be successful (according to the manufacturer's manual and our experience). We used Cell Saver (Haemonetics 5+, USA) apparatus; blood was collected, processed and reinfused to the patients or by the trained anesthesiology technician. One unit of autologous blood was 250 mL.

Hemoglobin levels were measured preoperatively, and postoperatively after 6, 24 and 48 h for all the patients. Preoperatively, as well as 24 h after the surgery, we measured activated partial thromboplastin time (APTT) and partial thromboplastin time (PT).

TKR surgery was performed as a routine, with the use of pneumatic tourniquet inflated to the level 100 mmHg more than systolic pressure. The patients underwent general (balanced) anesthesia or spinal anesthesia, standardized in terms of drugs and procedures.

Postoperative blood losses were measured as losses in wound drains during the period of the first 48 h after the surgery for all the patients, accompanied with clinical examination of the patients.

The time when patients sat, stood, walked and had their meal for the first time after the surgery recorded, to indirectly measure the quality of postoperative recovery. The length of staying in hospital was also recorded.

The exclusion criteria for this study were: patients with septic complications, multiple fractures, malignancy, American Society of Anaesthesiologists (ASA) physical status classification IV or more, hemiarthroplasty and all patients with incomplete data.

All the data were analyzed in SPSS 16.0 software package. All frequencies, percentages, and median standard deviation were calculated. Binary variables were compared by the χ^2 test, continuous variable were compared by the Fisher's Exact test and the *t*-test. A statistically significant difference was defined as p value < 0.05. All data (text, tables, and charts) were arranged by Microsoft Word 2003 and Microsoft Excel 2003.

Results

Out of 112 patients, 86 were women and 26 men. For the purpose of this study we compared age, gender, ASA status, comorbidities, chronic non-steroidal anti-inflammatory drugs (NSAID) and aspirin use, anesthesia method, the type of prosthetic material, perioperative levels of hemoglobin, hematocrit, thrombocyte count, the mechanism of hemostasis, blood losses, the number of blood units of allogeneic and autologous blood per each patient, the time when patients sat, stood, walked and had their meals for the first time after the surgery, as well as the length of staying in hospital to evaluate their impact on the outcome of the surgery.

In both groups the majority of patients were women, 86 (76.78%).

The American Society of Anesthesiology (ASA) status III (ASA III) patients were most frequent in both groups – 83 patients in total (74.10%). There were no ASA I patients.

The majority of patients received spinal anesthesia – 83 (74.10%) patients, and 29 (25.90%) patients received general anesthesia. All the patients had a cemented knee prosthesis (Table 1).

Comparing hemoglobin and hematocrit levels measured postoperatively, there was a significant difference after 48 h in favour of the allogeneic group (Table 2). The values of APTT and PT preoperatively and 24 h postoperatively were higher and showed a significant difference in the autologous group (Table 2). That can be explained by blood processing in the autologous transfusion method. In this process only “washed” erythrocytes are reinfused back to the patient, and the rest of plasma and coagulation factors, with cell detritus,

Table 1
General characteristics of the patients

Characteristics	Autologous group	Allogeneic group	<i>p</i> -value
Mean age (min–max)	65.24 (50–81)	67.72 (53–82)	0.05
Gender, n (%)			
male	14 (25.5)	12 (21.1)	
female	41 (74.5)	45 (78.9)	
Methods of anesthesia, n (%)			
general	16 (29.1)	13 (22.8)	0.05
spinal	39 (70.9)	44 (77.2)	0.05
Type of knee prosthesis, n (%)			
cemented	55 (49.1%)	57 (50.88%)	0.05
cementless	0	0	

Table 2
Preoperative and postoperative mean values of hemoglobin, hematocrit, thrombocytes, activated partial thromboplastin time (APTT), partial thromboplastin time (PT) and blood losses

Parameters	Autologous group	Allogenic group	<i>p</i> value
Hemoglobin (g/L)			
preoperatively	134.85	133.94	0.05
postoperatively:			
6 hrs	121.62	119.12	0.05
24 hrs	110.15	110.54	0.05
48 hrs	97.62	107.40	0.01
Hematocrit (g/L)			
preoperatively	39.83	38.99	0.05
postoperatively:			
6 hrs	35.25	34.86	0.05
24 hrs	32.07	32.18	0.05
48 hrs	27.65	31.14	0.01
Thrombocytes ($\times 10^9/L$)			
preoperatively	252.55	268.93	0.05
postoperatively:			
6 hrs	187.95	202.53	0.05
24 hrs	177.62	188.49	0.05
48 hrs	161.22	190.35	0.01
APTT (sec.)			
preoperatively	0.934 (0.78–1.14)	0.932 (0.74–1.13)	0.05
after 24 hrs	0.974 (0.79–1.25)	0.941 (0.80–1.11)	0.01
PT (sec.)			
preoperatively	0.944 (0.82–1.17)	0.991 (0.86–1.20)	0.01
after 24 hrs	1.199 (0.94–1.72)	0.986 (0.10–1.21)	0.01
Blood losses (mL)			
postoperatively:			
immediately postoperatively	1229.06 (300–3000)	1328.0 (800–2800)	0.05
after 24 hrs	252.88 (50–900)	401.75 (100–1450)	0.01
after 48 hrs	206.67 (50–900)	240.60 (100–1100)	0.05

Comorbidities were very frequent; almost all the patients had some comorbidities – 99 of them (88.39%) in both groups; only 13 (11.6%) patients had none.

Almost all the patients in both groups used some aspirin or NSAIDs, only one patient did not use any of these drugs.

anticoagulants, normal saline and bone micro fragments are disposed and wasted.

In both groups, most prominent postoperative blood losses were in the immediate postoperative period. In the autologous group blood losses were less in general. There

were statistically significant difference in the blood losses in the first 24 hours postoperatively, blood losses were significantly less in the autologous group (Table 2).

Out of 55 patients in the autologous group, only 5 (9.09%) patients received an additional transfusion of allogeneic blood (n = 8 units of allogeneic blood), while 50 (90.99%) patients received only their own (autologous) blood.

In the allogeneic (control) group 56 patients received allogeneic blood, 32 (57.1%) patients, received 2 units of allogeneic blood, 7 (12.5%) patients received 1 unit of allogeneic blood, 17 (30.4%) patients received more than three units of allogeneic blood. Only one patient did not receive allogeneic blood (Table 3).

Table 3
The number of blood units in autologous and allogeneic group of the patients

Blood units	Autologous group	Allogeneic group
	n (%)	n (%)
Allogeneic		
1	2 (40)	7 (12.5)
2	3 (60)	32 (57.1)
> 3	0 (0)	17 (30.41)
Autologous		
1	22 (40)	0
2	22 (40)	0
3	4 (7.3)	0
4	6 (10.9)	0
5	1 (1.8)	0

In the autologous group the majority of patients received one or two units of autologous blood (n = 22 patients), four patients got 3, six patients got 4, only one patient got 5 units of autologous transfusion (Table 3).

The time when patients sat, stood, walked and had their meal for the first time after the surgery served as the indirect indicator of postoperative recovery quality. In the autologous group, the patients sat ($p < 0.001$) able to eat (their first meal) 18 h earlier than in the allogeneic (control) group ($p < 0.001$).

There was a significant difference ($p < 0.001$) in the length of staying in hospital. An average hospital stay in the autologous group was 6.18 days, and in the allogeneic (control group) 7.67 days. The final decision about when to discharge the patient from hospital was made by the attending surgeon (Table 4).

logeneic (control) group. One was the wound infection and other was chest pain with no major morbidity. In the autologous group there were no complications.

Discussion

The average patient in our study was female, 66.5 years old, ASA III status with comorbidities and chronic usage of NSAID's or aspirin. These data are consistent with the fact that indications for TKR surgery are degenerative diseases of the knee, which are painful and, more frequent in elderly females¹⁰.

The patients in the autologous group lost significantly less blood, in general. There is also a significant difference in the postoperative blood loss between two groups 24 h after the surgery. The patients in the autologous group lost less blood, too. Our study showed blood loss mostly in immediate postoperative period which is in accordance with some other studies¹¹.

We think that the most important result of our study is the result showing that autologous transfusion is a very effective measure in reducing consumption of allogeneic blood. In the allogeneic (control) group 98.24% of the patients postoperatively received allogeneic blood transfusion. In the autologous group of patients only 9.09% received allogeneic blood transfusion, which is almost ten times reduction in the consumption of this type of blood.

This is in accordance with the research performed by Thomas et al.¹¹ which showed the reduction of allogeneic blood consumption (only 7% in the research group received additional allogeneic blood transfusion). Some other studies, however, did not show that autologous transfusion reduced consumption of allogeneic blood transfusion^{12, 13}.

Recovery following TKR surgery is multifactorial, but there is a statistically significant difference in the speed and quality of postoperative recovery in the autologous group, accompanied with fewer complications. Unfortunately, we were not able to follow the patients and complication rate after hospital dismissal, and we know that such data (collected for the first six months postoperatively at least) could be very important for the introspection of this method itself. Hospital stay is reduced in this group of patients¹⁴.

Table 4
Postoperative recovery in autologous and allogeneic group of the patients

	Autologous group	Allogeneic group	p value
	mean (min-max)	mean (min-max)	
Postoperative recovery (h)			
sitting	9.35 (8-12)	24.21 (12-48)	<0.01
standing	23.78 (12-24)	24.21 (12-48)	>0.05
walking	24.65 (24-48)	27.15 (24-72)	>0.05
eating	9.67 (4-36)	27.37 (24-48)	<0.01
Hospital stay (days)	6.18 (2-11)	7.67 (3-14)	<0.01

We analyzed deep venous thrombosis (DVT), pulmonary thromboembolic complications, sepsis, wound infection and major cardiovascular complications. Perioperative complications were rare and there were only two cases in the al-

There is a shortage of blood everywhere in the world, the same situation is in Serbia, so every method that reduces consumption of allogeneic blood is of vital importance. In our country blood donation is voluntary, which leads to a

wrong conclusion that blood itself is free of charge. The process of making blood and blood components safe is an expensive part of blood production. The analysis of cost-effectiveness of autologous transfusion was not the aim of this study, and it is very hard to analyze it because there is no official data about the cost of blood in our country. Today, blood and blood products are safer than ever, but still there are some known morbidities and mortalities connected to allogeneic transfusion, so by reducing its consumption we reduce those risks. Autologous transfusion has its own costs, but an additional justification for its usage can be found in the improved safety of this method^{15, 16}.

This study, however, has some limitations. In spite of the local study recommendations for the transfusion trigger of 85 g/L, sometimes this strict protocol was not followed and some surgeons are still reluctant to apply these recommendations since they consider them too low. This fact maybe explains higher hemoglobin levels in the allogeneic

group, because there is a strict protocol appliance in the autologous group controlled by the anesthesia technician and the anesthesiologist.

The length of staying in hospital is reduced in the autologous group of patients. There is no consensus in our clinic about how long patients should be hospitalized after TKR surgery, so this decision was made by consulting the surgeon, as well.

Conclusion

Autologous blood transfusion is a very effective method for reducing consumption of allogeneic blood and that reduction, indirectly reduces all complication related to allogeneic blood transfusion. There is also a positive influence on postoperative recovery after total knee replacement surgery due to the reduction of hospital stay, and indirectly on the reduction of hospital costs.

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