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The Efficacy and Safety of Postoperative Autologous Transfusion of Filtered Shed Blood and Anticoagulant Prophylaxis in Total Knee Arthroplasty Patients

Kwon-Hee Park, MD, Sung-Rak Lee, MD, Jong-Mun Jin, MD and Myung-Sang Moon, MD
Department of Orthopaedic Surgery, Cheju Halla General Hospital, Jeju, Korea

Purpose: To assess the efficacy and safety of autologous transfusion of filtered shed blood in total knee arthroplasty (TKA).
Materials and Methods: A total of 42 patients with TKA (group A; without autologous transfusion in 15 patients, group B; with autologous transfusion in 27 patients) were evaluated retrospectively. The influence of autologous reinfusion of filtered blood, bleeding tendency, amount of blood drainage, rate of allogenic transfusion, and the postoperative changes of hemoglobin were analyzed.
Results: Allogenic transfusion was needed in 26.7% (4/15) of group A and none of group B till postoperative 48 hours. Till postoperative 14 days, 46.7% (7/15) of group A needed allogenic transfusion while 7.4% (2/27) in group B. The average drained blood volume was 1,197±400 mL in group A and 975±422 mL in group B. The average decrease of hemoglobin at postoperative 1, 7, and 14 days was 2.9±1.5, 2.9±1.6, and 2.3±1.5 g/dL respectively in group A and 2.7±0.8, 4.0±1.0, and 2.9±1.3 g/dL respectively in group B.
Conclusions: An autotransfusion system lowered the allogenic transfusion rate, while anticoagulants did not increase the amount of drained blood. An autotransfusion system with anticoagulants was effective and safe to save the shed blood in TKA.

Key words: **Total knee arthroplasty, Autotransfusion, Anticoagulants.**

Introduction

Suction drainage in total knee arthroplasty (TKA) has been used primarily to prevent hemoarthrosis, hematomas and infections, and secondly to promote wound healing and rehabilitation[1]. In general, a large amount of blood is lost during and after surgery, which requires allogenic transfusion to stabilize the patient's vital signs. To reduce the amount of allogenic transfusion, various autotransfusion systems have been introduced. TKA-associated deep vein thrombosis (DVT) can cause fatal pulmonary embolism (PE)[2] and prophylactic anticoagulants have been commonly used to prevent DVT. In this study, we assessed the efficacy of autologous transfusion of filtered shed blood on bleeding tendency and vital signs and safety of anticoagulation prophylaxis.

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Correspondence to: Sung-Rak Lee, MD.
Department of Orthopaedic Surgery, Cheju Halla General Hospital, 65 Doryeong-ro, Jeju 690-170, Korea.
Tel: +82-64-740-5030, Fax: +82-64-743-3110
Email: drthatka@yahoo.co.kr

Materials and Methods

1. Materials

Between January 2006 and May 2010, 42 female patients with unilateral TKA by a single surgeon were enrolled in the present study. Patients with a history of bleeding tendency were excluded. Fifteen TKA patients (group A) had a suction drain (Baro-Vac, Sewoon Medical, Cheonan, Korea) only without anticoagulant, while 27 TKA patients (group B) received autotransfusion (Consta-Vac, Stryker, Michigan, MI, USA) and anticoagulant therapy using Fondaparinux (Arixtra, Glaxo Smith Kline, London, England). The maximum negative pressure of Baro-Vac was 90 mm Hg and we used half pressure. The negative pressure of Consta-Vac was 50 mm Hg.

The mean age of group A and B patients was 72.9 (range, 54

to 82) and 71.0 (range, 58 to 82) years, respectively. The average body mass index (BMI) was 26.5% (±3.2) in group A and 24.6% (±3.0) in group B. The indication for TKA was primary osteoarthritis in all patients. The demographic data of the two groups were not significantly different (Table 1).

2. Operative Technique and Implants

Regional anesthesia (spinal, epidural or spinal-epidural combined) was performed in all patients. In group A, 7 spinal, 6 epidural and 2 spinal-epidural anesthesia types were used. In group B, 12 spinal, 10 epidural and 5 spinal-epidural anesthesia types were used. A unilateral, posterior substitute (PS) type cemented TKA using a medial parapatellar incision was performed. Patellar resurfacing was done and a pneumatic tourniquet was used during surgery in all patients. After tourniquet release, meticulous hemostasis was performed. The shed blood during this bleeding control period was discarded. Because the same operative procedure was performed in group A and B, we thought there were no significant differences in the discarded blood. Therefore, the blood lost during surgery was not measured and not included in this study.

In group A, 8 genesis II (Smith & Nephew, Memphis, TN, USA) and 7 Scorpio (Osteonics, NJ, USA) were used, and in group B, 11 Genesis II and 16 Scorpio were used.

3. Postoperative Management

Drainage was discontinued at 48 hours postoperatively in both groups because of a potential increase in the bacterial colonization rate if left longer. Group B patients received autotransfusion of the drained filtered blood that was collected during the first 6 postoperative hours, and the subcutaneous anticoagulant (Fondaparinux 2.5 mg per day: Arixtra) therapy was started at 6 hours postoperatively until postoperative day 7. In both groups, allogenic transfusion was indicated when the hemoglobin concentration was <7 g/dL or when vital signs were unstable or the hemoglobin concentration was <9 g/dL and acute hypovolemic symptoms developed such as hypotension below 100 mm Hg of systolic blood pressure, tachycardia above 100/min, decreased urine output below 20 mL/h, and dizziness[3,4].

To evaluate the clinical validity of autologous transfusion of the filtered shed blood, the frequency of allogenic transfusion was analyzed until the postoperative day 14, and the changes in hemoglobin were analyzed statistically at postoperative 24 hours, day 7 and day 14. To evaluate the effect of anticoagulant prophylaxis on bleeding tendency, the amount of drained blood was analyzed till 48 hours postoperatively. The symptoms of thrombophlebitis were also checked till the 14th postoperative day. The percentage of patients needing an allogenic transfusion in each group was determined. Statistical analysis was performed using chi-square analysis for categorical data. The amount of drained blood and reduction in hemoglobin according to the usage of anticoagulants were compared statistically by conducting the Student's *t*-test. All statistical analyses were performed with an IBM SPSS statics ver. 19 (IBM Corporation, Somers, NY, USA). A p-value<0.05 was considered statistically significant.

Table 1. Demographic Data of the Patients in This Study

	Group A	Group B
No. of patients	15	27
Mean age	72.9 (54-82)	71.0 (58-82)
Body mass index (%)	26.5±3.2	24.6±3.0

Results

1. The Frequency of Allogenic Transfusion

Allogenic transfusion was needed in 26.7% (4/15) of patients in group A and none in group B until 48 hours postoperatively. Until postoperative day 14, transfusion was needed in 46.7% (7/15) of patients in group A and 7.4% (2/27) in group B. Statistically, the autotransfusion system reduced allogenic transfusion rates (p<0.05) (Table 2).

2. Autologous Tranfusion and Autotransfusion System-Related Complications

The average amount of autotransfusion was 490 mL (±202). No complications (febrile reaction, bacterial infection, fat embolism,

Table 2. The Rate of Allogenic Transfusion, Amount of Drained Blood and Change of Hemoglobin

	Group A (n=15)	Group B (n=27)	p-value
Allogenic transfusion (till POD 2nd day)	4/15 (26.7)	0/27 (0)	0
Allogenic transfusion (till POD 14th day)	7/15 (46.7)	2/27 (7.4)	0.005
Amount of drain (till postoperative 48 hr)	1,197±400	975±422	0.104
Preoperative hemoglobin (g/dL)	12.0±1.1	12.4±0.9	0.219
Change of Hb (POD 1, g/dL)	2.9±1.5	2.7±0.8	0.564
Change of Hb (POD 7, g/dL)	2.9±1.6	4.0±1.0	0.021
Change of Hb (POD 14, g/dL)	2.3±1.5	2.9±1.3	0.221

Values are presented as number (%) or mean±standard deviation.
POD: postoperative day, Hb: hemoglobin.

coagulopathy, itching and urticaria, etc.) related to autologous transfusion of the filtered shed blood were noted clinically.

3. The Amount of Drained Blood

The average amount of drained blood was 1,197 mL (±400) in group A and 975 mL (±422) in group B until 48 hours postoperatively. The use of an anticoagulant (Fondaparinux: Arixtra) did not result in significant increases in the amount of drained blood ($p>0.05$) (Table 2).

4. The Average Hemoglobin Level

The average preoperative hemoglobin level was 12.0 (±1.1) in group A and 12.4 (±0.9) in group B. The postoperative hemoglobin level was measured at postoperative days 2, 7 and 14. The average decrease in the hemoglobin level at 24 hours postoperatively and at postoperative days 7 and 14 was 2.9 g/dL (±1.5), 2.9 g/dL (±1.6) and 2.3 g/dL (±1.5), respectively, in group A and 2.7 g/dL (±0.8), 4.0 g/dL (±1.0) and 2.9 g/dL (±1.3), respectively, in group B. A statistically significant intergroup difference was found in the value obtained at 24 hours postoperatively ($p<0.05$), not at postoperative days 7 and 14 ($p>0.05$) (Table 2).

5. Complications Related to Prophylactic Anticoagulant Therapy

No specific complication was noted postoperatively in group A and B. To diagnosis DVT, we checked clinical symptoms such as pain, edema, tenderness, body temperature, heart rate and Homan's sign, and related symptoms were not noted in both groups. Particularly in group B with anticoagulant therapy, no complications such as bleeding, hematoma or wound problems developed until postoperative day 14. We did not find any surgical site complications that correlated with BMI either. The anesthesiologist did not consider the regional anesthesia method using anticoagulants. The epidural catheters were removed by 48 hours postoperatively in all patients and no complication such as epidural hematoma developed.

Discussion

1. The Effect and Safety of Autologous Transfusion of Filtered Shed Blood

Blood loss after TKA has been known to be about 500-1,500 mL. It has been known that the amount of blood loss affects the prognosis of TKA[5]. Therefore, various autotransfusion systems have been used to reduce the side effects of allogenic transfusion and to save shed blood. In some studies, autologous transfusion of filtered shed blood resulted in complications such as febrile reaction, hypotension, bacterial infection, fat embolism, coagulopathy, itching and urticaria[6-8]. However, these side effects have been rarely reported. In addition, the safety of filtered shed autotransfusion has been documented in various studies[9-14]. In our study, no complications related to autologous transfusion were noted in the clinical assessment.

Allogenic transfusion was needed in 26.7% (4/15) of patients in group A and none in group B until 48 hours postoperatively. Until postoperative day 14, the transfusion was needed in 46.7% (7/15) of patients in group A and 7.4% (2/27) in group B. The autotransfusion system (Consta-Vac) was effective in lowering the incidence of allogenic transfusion at a significant level ($p<0.001$).

2. The Effect and Safety of Anticoagulant

The use of prophylactic anticoagulant is important because the incidence of DVT after TKA is higher than other surgeries and DVT can cause fatal PE. Stulberg et al.[15] reported about 84% deep-vein thrombosis following total knee replacement without anticoagulant prophylaxis. Cha et al.[16] reported that venous thromboembolism occurred in 40.4% of cases following total knee replacement without anticoagulant prophylaxis and that TKA was a risk factor for DVT and PE. Some studies reported that the incidence of DVT in Asians was low[17,18], but recent epidemiological studies disclosed that the incidence of DVT in Asians has been increasing[19,20]. Brookenthal et al.[2] reported the overall incidence of fatal PE was 0.22% and Howie et al.[21] and SooHoo et al.[22] reported 0.15% and 0.41% of fatal PE within 90 days after TKA. The use of prophylactic anticoagulant is very important because of the high mortality of symptomatic PE[23].

To prevent DVT, standard pneumatic compression, inferior vena cava filter and pharmacologic prophylaxis can be used. The existing pharmacologic options are parenteral heparin, oral warfarin (inhibitor of vitamin K), low-molecular-weight heparin (Dalteparin, Enoxaparin, Lovenox), Fondaparinux (inhibitor of factor Xa) and inhibitor of platelet aggregation (Aspirin, Naproxen, NSAIDs). An oral form of heparin (Melagtran, Ximelagatran, Dabigatran, Rivaroxaban, Apixaban) as well as direct thrombin inhibitors of factors IIa, IXa and Xa are being developed[24-26]. Fondaparinux sodium (Arixtra 2.5 mg/0.5 mL) is the first synthetic inhibitor of factor Xa and has a single molecular target within the coagulation cascade. In the current series, it was administered subcutaneously from 6 hours after surgery until 5-9 days following surgery (2.5 mg once daily)[27].

The anticoagulant-related complications include bleeding, hematoma and wound problem[5,28]. However, Turpie[27] presented rare side effects of fondaparinux including bleeding until postoperative day 11. To evaluate the effect and safety of anticoagulants on bleeding tendency, blood analysis has to be done but unfortunately it is an expensive procedure. Bleeding is the most concerning side effect of anticoagulant therapy. Therefore, we simply evaluated the amount of drained blood. It is simple and economical, and has high clinical validity. We believe the amount of drained blood reflects bleeding tendency clinically. In most cases, bleeding stopped within 2-3 postoperative days, and consequently the drainage was also removed[1,6,9,10,29]. The average amount of drained blood until 48 hours after surgery was 1,197 mL (±400) in group A and 975 mL (±422) in group B. Anticoagulant therapy did not significantly increase the amount of drained blood ($p>0.05$). High incidence of DVT can cause fatal PE secondarily. Therefore, a prophylactic anticoagulant is recommended. As a result, non DVT was complicated in the current series.

3. The Limitation of This Study

Limitations of this study include the lack of providing the amount of blood loss during wound closure after tourniquet release, planned blood analysis (bleeding time, coagulation time and prothrombin time) and accurate diagnosis of DVT postoperatively. The assumptive asymptomatic complications such as hemoarthrosis and asymptomatic DVT have to be evaluated prospectively.

We expected that the average hemoglobin level would not be different between group A and B, but there were statistically significant differences at postoperative day 7. We hypothesized that this was attributable to either allogenic transfusion or the anticoagulant. In group A, allogenic transfusion was needed in 46.7% (7/15) of patients until postoperative day 7. In group B, allogenic transfusion was needed in 7.4% (2/27) of patients due to anemia at 7 days postoperatively and gastroduodenal ulcer at 10 days postoperatively. High frequency of allogenic transfusion in group A would have affected the hemoglobin level at 7 days postoperatively. Also, the hemodynamic effect of anticoagulants has the potential of lowering the hemoglobin at 7 days postoperatively. Further evaluation is needed fully clarify this issue.

Conclusions

An autotransfusion system (Consta-Vac) reduced the allogenic transfusion rates. Anticoagulants (Fondaparinux: Arixtra) did not increase the amount of drained blood. Autotransfusion system with anticoagulant was effective and safe to save shed blood and prevent thrombophlebitis and thromboembolism after TKA.

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