Significantly Reducing Blood Loss Using Intra-muscular Injection of Tranexamic Acid during Total Knee Arthroplasty

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Abstract

Background

Administration of an intra-muscular injection (IMI) of tranexamic acid (TXA) had been demonstrated to be effective in reducing both blood loss and the transfusion rate during total knee arthroplasty (TKA). However, few studies have reported on the efficiency of IMI of TXA. We studied the efficiency of IMI of TXA to reduce blood loss during TKA.

Methods

In this prospective study, 50 patients undergoing primary simultaneous bilateral TKA were enrolled. The right knee received a IMI of 1 g of TXA (Group I), and the left knee received an intra-articular injection (IAI) of 1 g of TXA (Group II). The clinical outcome measures were a change in hemoglobin levels, blood loss from Hemovac, and number of allogeneic blood units.

Results

Compared with Group II, the decrease in blood loss from Hemovac was significantly less for Group I (460.1 ± 36.79 vs. 576.0 ± 34.01 , $P < 0.001$), and no significant difference in surgical times was observed.

Conclusions

IMI of TXA can significantly reduce blood loss than IAI of TXA during TKA without increased complications such as surgical site infection, poor wound healing, skin necrosis, pulmonary embolism, and deep vein thrombosis.

Background

Knee osteoarthritis is an increasingly common disease that causes knee pain, limited range of motion, and reduced quality of life and ability to conduct activities of daily living. Total knee arthroplasty (TKA) is a reliable surgical method for treating these signs and symptoms. However, postoperative blood loss is a major risk during TKA. Studies conducted between the years 2000 and 2009 have reported blood loss of 1000–1790 mL during unilateral TKA and an increase in the incidence of allogeneic blood transfusion [1–4]. More blood loss and higher incidences of complications such as anemia, weakness with delayed rehabilitation, and poor wound healing have previously been noted [5]. Although allogeneic blood transfusions are a safe and effective treatment for considerable postoperative bleeding, blood transfusions have potential risks, including the risks of immunological allergy, infection, and mortality; in addition, blood transfusions lengthen hospital stays and increase costs. Therefore, numerous approaches have been developed to reduce the amount of blood loss and the rate of blood transfusion

such as minimally invasive surgery, the use of a tourniquet during surgery, and hypotension anesthesia. In addition, the use of intravenous and intra-articular tranexamic acid (TXA) has been reported to safely and effectively reduce the amount of blood loss and likelihood of blood transfusions in TKA [6–8].

Peri-articular injection (PAI) of multimodal drugs, which are directly applied into the soft tissue around the surgical site, is an efficient means of reducing postoperative pain, shortening hospital stays, and enabling patients to be rehabilitated earlier [9–12].

However, reports on the efficacy of intra-muscular injection (IMI) using a local-pain-control cocktail combined with TXA in TKA are few [13–15]. Therefore, in this study, we compared blood loss during bilateral TKA when one knee received intra-muscular TXA injection and the other knee received intra-articular TXA injection.

Methods

A total of 50 patients who underwent simultaneous bilateral TKA for advanced knee osteoarthritis from January to August 2017 were included in this prospective study. The inclusion criteria were ≥ 60 years of age diagnosis of advanced knee osteoarthritis, and receipt of bilateral TKA. The exclusion criteria were a history of knee surgery, inflammatory arthritis, and osteoarthritis due to infection, unilateral TKA, renal failure and a bleeding or platelet disorder. Patient demographic data that were collected, such as age, sex, body mass index (BMI), and Charlson comorbidity index [16].

Group I comprised right knees that received IMI of TXA (1 g/10 mL). Group II comprised left knees that received IAI of TXA (1 g/10 mL).

The surgical procedures were performed by one single experienced joint surgeon. During surgery, the patients were in the supine position and under spinal anesthesia. Before skin incision, the tourniquet was inflated until the pressure to 280 mmHg. It was then deflated after the IMI or IAI of TXA. A curved skin incision was made via a midvastus approach. The prosthesis used was the cement-fixed NexGen posterior-stabilized knee system (Zimmer Biomet). The sites of IMI were the rectus femoris, vastus medialis, patella tendon, pes anserinus, and posterior capsule. Surgical drains were inserted into the joints and clamped, then opened 1 hour after surgery, suctioned using full-negative pressure, and removed 48 hours after surgery. Standard wound closure was performed, and sterile dressing was applied. The procedures were performed on the right knee first then on the left knee.

The postoperative regimes were the same for all patients except for those with a BMI greater than 30 kg/m^2 . These patients received an injection of low-molecular-weight heparin at 2000 international units daily for 3 days to prevent thromboembolism. Hemoglobin (Hb) level was rechecked on the first day after the operation. The criteria for blood transfusion were $\text{Hb} < 8 \text{ mg/dL}$ and a decrease in the Hb level of more than 3.0 mg/dL if the patient had intolerable symptoms or organ dysfunction due to anemia. All patients underwent mobilization on the first postoperative day and were discharged 5 days after surgery.

The clinical outcomes were the Hemovac volume of each knee, Hb level change, and transfusion rate.

All analyses were performed using IBM SPSS Statistics 22.0 (IBM, Armonk, NY, USA). The characteristics of the two groups were analyzed using one-way analysis of variance (age, BMI, ASA, Charlson comorbidity index, pre- and postoperative Hb level, preoperative platelets, surgery time, and total Hb reduction) and the chi-squared test (sex and transfusion rate). The numbers of units was assessed using the Kruskal–Wallis test. $P < 0.05$ was considered statistically significant.

This clinical study was approved by the institutional review board at our hospital, Taipei

Veterans General Hospital. (IRB number: 2018-09-004CC)

Results

During the period from January to August 2017, 50 patients who met the inclusion criteria were enrolled in Group I for simultaneous bilateral TKA. The right knees (Group I) received IMI of TXA (1 g/10 mL), whereas the left knees (Group II) received IAI of TXA (1 g/10 mL).

The demographic data and preoperative blood test results of the patients, and a comparison of the results between Group I and Group II are presented in Table 1.

Table 1
Patient-Demographic and Pre- and Post-operative data

Number	50		
Age (years)	70.46 ± 1.26		
Gender			
Male/Female	36.0% (18/50) / 64.0% (32/50)		
BMI (kg/cm ²)	27.65 ± 0.46		
ASA	2.44 ± 0.07		
Charlson index score	1.30 ± 0.15		
Hb preoperative (mg/dL)	12.77 ± 0.24		
PLT count preoperative (count x 10 ³ /mm ³)	217.6 ± 7.89		
Hb postoperative (mg/dL)	10.51 ± 0.23		
Hb change (mg/dL)	-2.26 ± 0.21		
Transfusion rate (number/%)	8 (16%)		
	Peri-articular injection (Group I)	Intra-articular injection (Group II)	<i>P</i> value
Number	50	50	
Surgery time	33.96 ± 0.73	34.9 ± 0.83	0.065
Hemovac volume (ml)	460.1 ± 36.79	576.0 ± 34.01	< 0.001

In Group I, the mean surgical time was 33.96 ± 0.73 minutes and the mean Hemovac volume was 460.1 ± 36.79 mL. In Group II, these values were 34.9 ± 0.83 minutes and 576.0 ± 34.01 mL, respectively..

Comparing Group I and Group II, the Hemovac volume was significantly lower in Group I ($P < 0.001$). The mean surgical times of the two groups did not significantly differ ($P = 0.065$).

The Hb level change of the patients was - 2.26 ± 0.21 mg/dL and the transfusion rate was 16% (8/50). No patients had major or minor complications such as deep vein thrombosis, pulmonary embolism, surgical site infection, poor wound healing, and skin necrosis.

Discussions

According to reports, IAI of TXA results in significant reductions of blood loss, blood loss via the surgical drain, and Hb decrease [2, 8, 17–19]. Seo et al. reported that the transfusion frequencies after placebo, intravenous injection, and IAI of TXA were 94%, 34%, and 20%, respectively, and that these rates significantly differed between the intravenous injection and IAI of TXA groups. [17].

The blood loss noted after TKA was bone oozing and soft-tissue oozing. previously cement was placed between the bone-cutting site and implant component to reduce bone oozing, and IAI of TXA was employed to reduce blood oozing after synovectomy. However, muscle oozing was not effectively managed using this approach, and the studies on IMI of TXA in unilateral TKA are limited [13–15]. Mao et al. demonstrated that IMI and IAI of TXA efficiently at reducing blood loss during TKA compared with a control group; but the difference between IMI and IAI was nonsignificant [13]. Pinsornsak et al. reported that the antibleeding effects of intramuscular injected and intravenous injected TXA were similar [14]. Yozawa et al. reported that compared with placebo treatment, IMI of TXA was efficient at decreasing blood loss and drops in Hb and hematocrit [15].

In our study, IMI of TXA was more efficient at reducing blood loss in simultaneous bilateral TKA than IAI of TXA. Comparing Groups I and II, the Hemovac volumes of the IMI group (Group I) were significantly lower than those of IAI group (Group II) (460.1 ± 36.79 mL vs. 576.0 ± 34.01 mL, $P < 0.001$). The blood transfusion rate was 16% in our study, lower than that in the study of Seo et al. on unilateral TKA (20%) [17].

Consequently, we conclude that IMI of TXA is effective at reducing blood loss and the blood transfusion rate in simultaneous bilateral TKA and that the pain-control cocktail plus TXA is safe for patients, not resulting in skin infections, poor healing, or necrosis.

Our study had two limitations. First, coagulation ability may influence their amount of blood loss during a procedure. All patients in our study received right TKA first, followed by left TKA. Second, the optimal dose of TXA was not clarified; more prospective-randomized studies are required to determine the most efficient TXA dose.

Conclusions

IMI of TXA can significantly reduce blood loss than IAI of TXA during TKA without causing deep vein thrombosis, pulmonary embolism, or skin problems.

Abbreviations

IMI

intra-muscular injection

TXA

tranexamic acid

TKA

total knee arthroplasty

IAI

intra-articular injection

BMI

body mass index

ASA

American Society of Anesthesiologists

Hb

hemoglobin

Plt

platelet

Declarations

Ethics approval and consent to participate:

The consent statement was not required due to it was a retrospective study which had been approved by the institutional review board at our hospital, Taipei Veterans General Hospital. (IRB number: 2018-09-004CC).

Consent for publication:

Not applicable

Availability of data and materials:

The datasets analysed during the current study are not publicly available due to the data and materials were accessed from the case system of our department. They are available from the corresponding author on reasonable request.

Competing interests:

The authors declare that they have no competing interests.

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Authors contributions

C.-F. C. and W.-M. C. designed the work. Y.-K. L. drafted the work and P.-K. W. substantively revised it. S.-W. T., C.-M. C., J. CS Y., and Y.-K. L. also acquisition the data and analyzed them. All authors read and approved the final manuscript.

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