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Original Article

Clinical study of the optimal dose of intravenous tranexamic acid guided by thrombelastogram during the perioperative period of total knee arthroplasty

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Abstract: Objective: To evaluate the blood protective effect of tranexamic acid on patients undergoing total knee arthroplasty (TKA) by thrombelastogram (TEG), and to determine the optimal dosage of tranexamic acid. Methods: A total of 200 patients undergoing TKA admitted to the department of orthopaedics of the First People's Hospital of Wenling City from January 1, 2017 to May 1, 2018 were selected as subjects, who were randomly divided into groups A, B, C, D and E. The group A was control group, and patients in the control group were given normal saline infusion. Patients in the groups B, C, D and E were given 10 mg/kg, 15 mg/kg, 20 mg/kg and 30 mg/kg of tranexamic acid, respectively. TEG parameters, the intraoperative blood loss, postoperative blood transfusion rate and incidence of deep vein thrombosis (DVT) of patients were compared among the groups. Results: The results of TEG showed that patients in the groups B, C, D and E had significantly lower postoperative coagulation time (K) and reaction time (R) values than those in the group A, but significantly higher postoperative maximum amplitude (MA) value than group A, (all $P<0.001$). There were no statistically significant differences in the postoperative K, R and MA values among the groups B, C, D and E (all $P>0.05$). The results of five routine coagulation parameters showed that patients in the groups B, C, D and E had higher postoperative fibrinogen (FIB) than those in the group A, and lower prothrombin time (PT), activated partial thromboplastin time (APTT), thrombin time (TT) and D-dimer than those in the group A (all $P<0.001$). There were no statistically significant differences in the postoperative PT, FIB, APTT, TT and D-Dimer values among the groups B, C, D and E (all $P>0.05$). Patients in the groups B, C, D and E had significantly lower intraoperative blood loss and postoperative blood transfusion rate than those in the group A (both $P<0.001$). There were no statistically significant differences in the intraoperative blood loss and postoperative blood transfusion rate among the groups B, C, D and E (all $P>0.05$). There was no statistically significant difference in the incidence of DVT among the groups (all $P>0.05$). Conclusion: Tranexamic acid applied in TKA is beneficial in protecting coagulation system during the operation. There is no significant difference in the blood protection effect on patients undergoing TKA among 10 mg/kg, 15 mg/kg, 20 mg/kg and 30 mg/kg, so the lowest dose of 10 mg/kg is recommended.

Keywords: Tranexamic acid, total knee arthroplasty, thrombelastogram, blood transfusion rate, intraoperative blood loss, deep vein thrombosis

Introduction

Total knee arthroplasty (TKA), one of effective methods for treating end-stage primary knee arthritis, significantly relieves patients' pain, and improves their knee function and quality of life [1, 2]. In recent years, TKA is widely applied. During its perioperative period, the significant problems of blood transfusion and blood loss have become more and more prominent, which have been increasingly valued by clinical orthopedists [3, 4]. A large amount of blood loss may cause shock or even life-threatening in elderly patients with poor cardiopulmonary function. Blood transfusion may cause viral infection, hemolytic reaction and blood transfusion-related sepsis. It can be seen that reducing the blood loss and blood transfusion during the perioperative period of TKA is very important.

As an antifibrinolytic drug, tranexamic acid is a synthetic derivative of lysine that reversibly blocks lysine binding sites in plasminogen to achieve an antifibrinolytic effect [5, 6]. Tranexamic acid applied in surgery reduces the intraoperative and postoperative blood loss in patients [7-9]. However, a previous study reported that intravenous tranexamic acid may increase the risk of deep vein thrombosis (DVT) in the lower extremity and pulmonary embolism of patients [10]. At present, tranexamic acid has no recognized optimal dosage, and its dose varies greatly in studies [11]. Most studies reported that its dose in the perioperative period of TKA is 10-30 mg/kg [12]. In TKA, the choice of the optimal dosage of tranexamic acid is still controversial [13-15]. A study showed that as an image that reflects the whole process of coagulation, thrombelastogram (TEG) comprehensively monitors the coagulation process involved by coagulation factors, fibrinogen (FIB) and platelets (ref). During the perioperative period, it dynamically guides clinically rational component transfusion, which has important clinical significance for reducing the blood loss and blood transfusion volume [16]. In this study, 200 patients undergoing unilateral TKA admitted to the First People's Hospital of Wenling City from January 2017 to May 2018 were selected as subjects. TEG was used for analyzing the coagulation function to evaluate the effects of different doses of tranexamic acid on the blood loss and blood transfusion in TKA, and to further determine the optimal dosage of tranexamic acid during the operation, in order to provide experimental basis for clinical treatment.

Materials and methods

General information

A total of 200 patients admitted to the department of orthopaedics of the First People's Hospital of Wenling City and underwent TKA from January 1, 2017 to May 1, 2018 were selected as subjects, who were randomly divided into five groups, with 40 patients in each group. The group A was the control group. At 30 minutes before the end of the operation to relax tourniquet, patients in the control group were given a corresponding dose of normal saline. The group B was 10 mg/kg tranexamic acid group, the group C was 15 mg/kg tranexamic acid group, the group D was 20 mg/kg tranexamic acid group, the group E was 30 mg/kg tranexamic acid group. At 30 minutes before the end of the operation to relax the tourniquet, different concentrations of tranexamic acid were diluted in 100 mL of normal saline according to the grouping standard and then infused.

Inclusion criteria: (1) Patients older than 60 years, and the primary disease of the knee was rheumatoid arthritis (RA) or advanced osteoarthritis. The diagnosis of RA was based on the classification criteria for RA proposed by the American College of Rheumatology (ACR) and the European League Against Rheumatism (EULAR) in 2010 [17]. The diagnosis of osteoarthritis was based on the diagnostic criteria for osteoarthritis proposed by the EULAR in 2003 [18]. Both of them led to knee pain and dysfunction. Patients had surgical indications of TKA and underwent surgery after the active control of inflammation. (2) Patients underwent routine blood test and had normal coagulation function, and the preoperative B-ultrasound of double limb deep vein displayed no DVT. (3) Patients actively cooperated with the study.

Exclusion criteria: (1) Those with obvious tendency to thrombosis, such as with pulmonary embolism, acute cerebral infarction or experiencing severe trauma and major operation within the first half of the year. (2) Those allergic to tranexamic acid. (3) Those requiring bilateral TKA who had bilateral knee lesion. (4) Patients with anemia or complicated with severe liver and kidney dysfunction, cardio-cerebral vascular disease or other basic diseases who cannot tolerate operation or had contraindications to operation. (5) Patients who had taken anticoagulant drugs for treatment in the past 3 months. The study was approved by the Ethics Committee of the First People's Hospital of Wenling City. All patients enrolled signed an informed consent form.

Operative methods

TKA was performed by the same group of surgeons. The affected limb was raised before operation and squeezed to accelerate venous return. The pneumatic tourniquet was then inflated for hemostasis. After general anesthesia, the patient was placed in a supine position, with the affected limb in a kneeing position. The longitudinal incision was made in the middle skin of the knee. The tissue was separated layer by layer from the medial side of the neck patella to fully expose the joint cavity. Intramedullary positioning was used to perform osteotomy on the distal femur, intramedullary positioning to perform the osteotomy on the tibia. The osteotomy surface was covered with bone cement, and the appropriate tibial prosthesis and femoral prosthesis (ZIMMER, USA) were installed in sequence. The prosthesis was firmly bound to the osteotomy surface by the bone cement. The tibia was not replaced but partially trimmed. The tourniquet wound was loosened for tight hemostasis, and the drainage tube was left. Pressure dressing was performed on the incision after it was sutured layer by layer. At 30 minutes before the tourniquet loosened, different doses of tranexamic acid (Zhejiang Jinhua Kangenbei Biopharmaceutical Co., Ltd., China) were intravenously administered to patients in different groups. Cefotiam (Harbin Pharmaceutical Group Pharmaceutical General Factory, China) was routinely used after the operation to prevent infection, twice a day and 1.0 g intravenous infusion each time, for 3 days. Patients were encouraged to actively perform functional training, including muscle strength training, joint activity training, balance function and gait training.

Outcome measures

The TEG parameters of patients in each group before the tranexamic acid infusion and at the end of the operation were recorded, including the reaction time (R), coagulation time (K) and maximum amplitude (MA) values. TEG examination was performed on 3 mL of venous blood extracted from patients in each group before the tranexamic acid infusion and at the end of the operation. TCA6000 thromboelastography was purchased from Zhejiang Shengyu Medical Technology Co., Ltd. Five routine coagulation parameters of patients before the tranexamic acid infusion and at the end of the operation were compared among the groups. SYSMEX-CS CS-5100 automatic coagulation analyzer (purchased from Sysmex SYSMEX Co., Ltd., Japan) was used to detect the five routine coagulation parameters, including prothrombin time (PT), activated partial thromboplastin time (APTT), fibrinogen (FIB), D-Dimer and thrombin time (TT). The intraoperative blood loss of patients was compared among the groups. The specific gravity of the blood was between 1.050 and 1.060, and 1 g of blood can be converted into 1 mL of blood. The intraoperative blood loss was the sum of the blood volume in the suction bottle and the gauze. The blood volume in the suction bottle was the difference between the total amount of liquid in the bottle and that of rinse liquid or normal saline applied during the operation. The blood volume in the gauze was the difference between the amount of blood gauze and that of dry gauze. The postoperative blood transfusion rate of patients was compared among the groups. Blood routine was performed on patients at 24 h and 72 h after the operation. If hemoglobin (Hb) was less than 80 g/L, patients were treated with 2U of red cell suspension until their Hb was above 100 g/L. The incidence of DVT of patients was compared among the groups. Vascular Doppler ultrasonography (Siemens, Germany, HDI-5000) was used at 2 weeks after the operation. If patients suffered from pain and swelling of the affected limb, which gradually worsened, urgent vascular ultrasound examination was performed on them to determine whether the thrombosis has formed.

Statistical processing

SPSS21.0 statistical software was used for analyzing and processing data. Measurement data were expressed as mean ± standard deviation ($\bar{x}$ ± sd). Independent sample t test was used for comparison between the two groups, paired t test for self-comparison, Dunnett-t test for comparison between multiple groups and the control group, bonferroni for pairwise comparison. Count data were expressed as number of cases/percentage (n/%), and χ^2 test was used for the comparison among the groups. When $P<0.05$, the difference is considered statistically significant.

Results

Comparison of baseline data among groups of patients

There were no statistically significant differences in the age, gender, body mass index, preoperative Hb concentration, disease type and course of disease of patients among the groups (all $P>0.05$). See **Table 1**.

Comparison of TEG parameters among groups of patients

There were no statistically significant differences in the preoperative K value ($F=0.303$, P=

Table 1. Comparison of basic data among patients

	Age (years old)	Male/female (case)	Body mass index (kg/m²)	Hb concentration (g/L)	Rheumatoid arthritis/ osteoarthropathy (case)	Course of disease (year)
Group A (n=40)	64.3±3.4	30/10	24.9±1.5	121.8±21.5	17/23	4.4±1.7
Group B (n=40)	65.1±4.7	27/13	24.6±1.8	125.4±19.8	20/20	4.5±1.8
Group C (n=40)	64.9±4.2	29/11	24.2±1.4	123.2±22.3	18/22	4.7±1.9
Group D (n=40)	65.6±3.8	26/14	24.5±1.2	124.6±20.8	19/21	4.0±1.5
Group E (n=40)	64.7±4.3	28/12	24.0±1.3	126.0±21.4	15/25	4.3±1.6
F/χ^2	0.551	1.190	2.325	0.259	1.498	0.921
P	0.699	0.880	0.058	0.904	0.827	0.453

Note: Hb, hemoglobin.

Table 2. Comparison of TEG indexes

Group	K (t/min)	R (t/min)	MA (t/min)
Group A			
Preoperative	4.5±0.9	10.7±1.1	55.3±6.2
Postoperative	5.5±0.8	15.6±1.4	45.1±4.7
Difference value	1.0±0.3	4.9±0.8	10.2±1.7
t	5.252	17.410	8.292
P	<0.001	<0.001	<0.001
Group B			
Preoperative	4.4±0.7	10.5±0.6	54.8±5.8
Postoperative	4.8±0.8	11.5±0.9	49.8±5.4
Difference value	0.4±0.2	1.0±0.4	5.0±1.3
t	2.380	5.847	3.990
P	0.019	<0.001	<0.001
Group C			
Preoperative	4.4±0.9	10.8±1.0	56.2±5.7
Postoperative	4.9±1.0	11.7±1.1	50.4±4.8
Difference value	0.5±0.3	0.9±0.3	5.8±1.4
t	2.351	3.829	4.923
P	0.021	<0.001	<0.001
Group D			
Preoperative	4.3±0.6	10.6±0.7	55.8±4.8
Postoperative	4.7±0.8	11.4±1.2	50.7±4.6
Difference value	0.4±0.1	0.8±0.3	5.1±1.2
t	2.530	3.642	4.852
P	0.013	<0.001	<0.001
Group E			
Preoperative	4.4±0.5	10.9±1.3	54.9±5.1
Postoperative	4.7±0.7	12.0±1.0	49.8±5.3
Difference value	0.3±0.1	1.1±0.4	5.1±1.0
t	2.206	4.242	4.385
P	0.030	<0.001	<0.001

Note: TEG, thrombelastogram; K, coagulation time; R, reaction time; MA, maximum amplitude.

0.876), R value (F=1.053, P=0.381) and MA value (F=0.462, P=0.763) of patients among the groups A, B, C, D and E. The postoperative K and R values of patients in groups were significantly higher than the preoperative K and R values, but the postoperative MA value was significantly lower than the preoperative MA value (all P<0.05). Patients in the groups B, C, D and E had significantly lower postoperative K value (F=6.569, P<0.001) and R value (F=98.850, P<0.001) than those in the group A, but significantly higher postoperative MA value (F=8.585, P<0.001) than those in the group A. There were statistically significant differences in the preoperative and postoperative TEG parameters of patients between the groups B, C, D, E and the group A (K value: F=64.170, P<0.001; R value: F=549.600, P<0.001; MA value: F=111.400, P<0.001). There were no statistically significant differences in the postoperative K value (F=0.529, P=0.663), R value (F=2.511, P= 0.061) and MA value (F=0.319, P=0.811) of patients among the groups B, C, D and E. There were no statistically significant differences in the preoperative and postoperative TEG parameters of patients among the groups B, C, D and E. See **Table 2**, **Figure 1**.

Comparison of coagulation function parameters among groups of patients

There were no statistically significant differences in the preoperative PT (F=1.092, P=0.362), FIB (F=1.205, P=0.310), APTT (F=2.052, P= 0.089), TT (F=0.291, P=0.884) and D-Dimer value (F=0.617, P=0.651) of patients among the groups A, B, C, D and E. The postoperative FIB of patients in groups was significantly lower than the preoperative FIB, but the postoperative PT, APTT, TT and D-Dimer were significantly higher than the preoperative PT, APTT, TT and D-Dinner (all P<0.001). Patients in the groups B, C, D and E had higher postoperative FIB

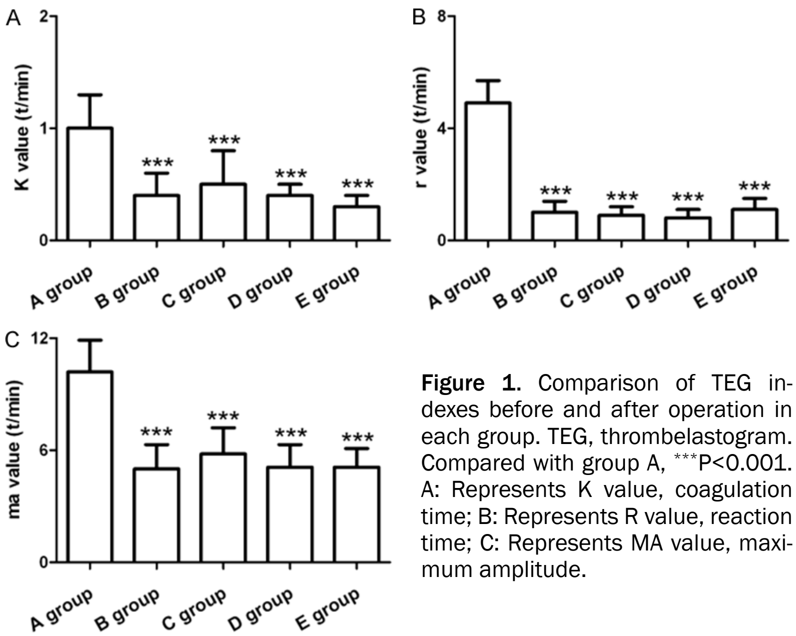

Figure 1. Comparison of TEG indexes before and after operation in each group. TEG, thrombelastogram. Compared with group A, ***P<0.001. A: Represents K value, coagulation time; B: Represents R value, reaction time; C: Represents MA value, maximum amplitude.

(F=14.810, P<0.001) than those in the group A, but lower postoperative PT (F=10.130, P<0.001), APTT (F=6.092, P<0.001), TT (F=3.646, P=0.007) and D-Dimer (F=134.900, P<0.001) than those in the group A. There were statistically significant differences in the preoperative and postoperative coagulation function parameters of patients between the groups B, C, D, E and the group A (PT: F=33.580, P<0.001; APTT: F=29.540, P<0.001; FIB: F=21.080, P<0.001; TT: F=33.320, P<0.001; D-Dimer value: F=397.700, P<0.001). There were no statistically significant differences in the postoperative PT (F=1.288, P=0.281), FIB (F=2.186, P=0.092), APTT (F=1.117, P=0.344), TT (F=0.436, P=0.728) and D-Dinner value (F=2.030, P=0.112) of patients among the groups B, C, D and E. There were no statistically significant differences in the preoperative and postoperative coagulation function parameters of patients among the groups B, C, D and E. See **Table 3**, **Figure 2**.

Comparison of intraoperative blood loss among groups of patients

The intraoperative blood loss of patients was (153.6±27.2) mL in the group A, (110.4±24.5) mL in the group B, (100.9±21.3) mL in the group C, (91.4±20.8) mL in the group D and (87.8±19.5) mL in the group E. Patients of the groups B, C, D and E had significantly lower intraoperative blood loss than that in patients of the group A (all P<0.001). There was no statistically significant difference in the intraoperative blood loss of patients among the groups B, C, D and E. See **Figure 3**.

Comparison of postoperative blood transfusion rate among groups of patients

In the group A, 24 patients were treated with the infusion of red cell suspension after operation. The postoperative blood transfusion rate of patients was 60.0 % (24/40) in the group A, 20.0% (8/40) in the group B, 15.0% (6/40) in the group C, 22.5% (9/40) in the group D and 17.5% (7/40) in the group E. Patients in the groups B, C, D and E had significantly lower postoperative blood transfusion rate than that in the group A, (all P<0.001). There was no statistically significant difference in the postoperative blood transfusion rate of patients among the groups B, C, D and E. See **Figure 4**.

Comparison of incidence of DVT among groups of patients

After operation, the incidence of DVT of patients was 5.0% (2/40) in the group A, 7.5% (3/40) in the group B, 10.0% (4/40) in the group C, 15.0% (6/40) in the group D and 17.5% (7/40) in the group E. There was no statistically significant difference in the incidence of DVT of patients among the groups. See **Figure 5**. In addition, no patients in groups had pulmonary embolism. See **Figure 5**.

Discussion

Abnormal bleeding is a severe complication of TKA, which affects patients' postoperative recovery. This may be related to bleeding on the cancellous bone surface and the bone marrow cavity during operation [19, 20]. Most people undergoing TKA are elderly patients who have poorer tolerance to blood loss. Blood loss increases their blood transfusion volume and corresponding transfusion complications, as well as the mortality during the perioperative period. There is dynamic equilibrium between

Table 3. Comparison of five indicators of coagulation

Group	PT (s)	APTT (s)	FIB (g/L)	TT (s)	D-Dimer (μg/L)
Group A					
Preoperative	10.9±1.7	32.3±2.4	3.0±1.1	14.8±3.1	156.7±35.2
Postoperative	17.8±2.9	39.4±4.1	1.3±0.3	20.6±4.1	512.8±42.9
Difference value	6.9±1.2	7.1±1.8	1.7±0.8	5.8±1.6	356.1±30.1
t	12.980	9.452	9.430	7.137	40.580
P	<0.001	<0.001	<0.001	<0.001	<0.001
Group B					
Preoperative	11.2±1.9	32.5±1.9	2.9±0.8	15.1±2.8	166.5±32.5
Postoperative	15.7±2.7	37.1±3.7	1.8±0.5	18.7±3.9	368.8±40.1
Difference value	4.5±1.1	4.6±1.5	1.1±0.5	3.6±0.9	202.3±25.6
t	8.620	6.995	7.374	4.742	29.690
P	<0.001	<0.001	<0.001	<0.001	<0.001
Group C					
Preoperative	10.7±1.6	31.8±2.1	3.1±1.0	14.6±2.5	160.9±30.4
Postoperative	15.4±2.6	36.8±3.5	2.1±0.6	18.5±3.6	355.4±38.7
Difference value	4.7±1.2	5.0±1.7	1.0±0.6	3.9±1.1	194.5±19.7
t	9.737	7.748	6.508	5.628	28.850
P	<0.001	<0.001	<0.001	<0.001	<0.001
Group D					
Preoperative	10.5±1.4	32.2±2.6	2.8±0.9	14.5±2.3	158.4±27.9
Postoperative	15.0±1.8	36.4±3.3	2.0±0.5	18.2±3.0	354.3±36.2
Difference value	4.5±1.0	4.2±0.9	0.8±0.2	3.7±0.9	195.9±18.9
t	12.487	5.245	4.300	6.190	27.110
P	<0.001	<0.001	<0.001	<0.001	<0.001
Group E					
Preoperative	10.9±2.0	32.7±2.3	2.9±0.7	14.7±3.2	161.3±25.3
Postoperative	14.8±1.7	36.8±2.9	2.1±0.6	17.9±2.8	349.4±31.9
Difference value	3.9±1.7	4.1±0.8	0.8±0.1	3.2±0.9	188.1±17.6
t	8.915	5.297	4.802	4.462	25.960
P	<0.001	<0.001	<0.001	<0.001	<0.001

Note: PT, prothrombin time; APTT, activated partial thromboplastin time; FIB, fibrinogen; TT, thrombin time.

the fibrinolytic system and the coagulation system in the body, which is effective on hemostasis when the body is traumatized, but it does not lead to pathological thrombus [21]. The coagulation system of patients undergoing TKA has different degrees of damage compared to normal people. Studies show that the tourniquet applied in TKA causes hypoxia in lower extremity vessels, which leads to the release of FIB activators from vascular endothelial cells, thereby promoting fibrinolysis and increasing blood loss [22, 23]. In addition, inflammatory reactions during surgery can lead to activation of coagulation system, consumption of coagulation factors, destruction of coagulation system and activation of fibrinolytic system, ultimately resulting in increase in the blood loss of patients [24]. These all have a negative impact on patients' prognosis.

Tranexamic acid is a potent fibrinolysis inhibitor that inhibits FIB activation and fibrin degradation. Its elimination half-life is 2 h, with 99% elimination after 7 half-lives. Its anti-fibrinolytic activity can be maintained for 7-8 h, and a longer time in the tissue for 17 h. The intravenous administration of tranexamic acid is one of main administration methods of TKA, which can quickly reach the effective concentration of drugs. Previous studies showed that the optimal dosage of tranexamic acid varies in different studies [25, 26]. TEG directly reflects pa-

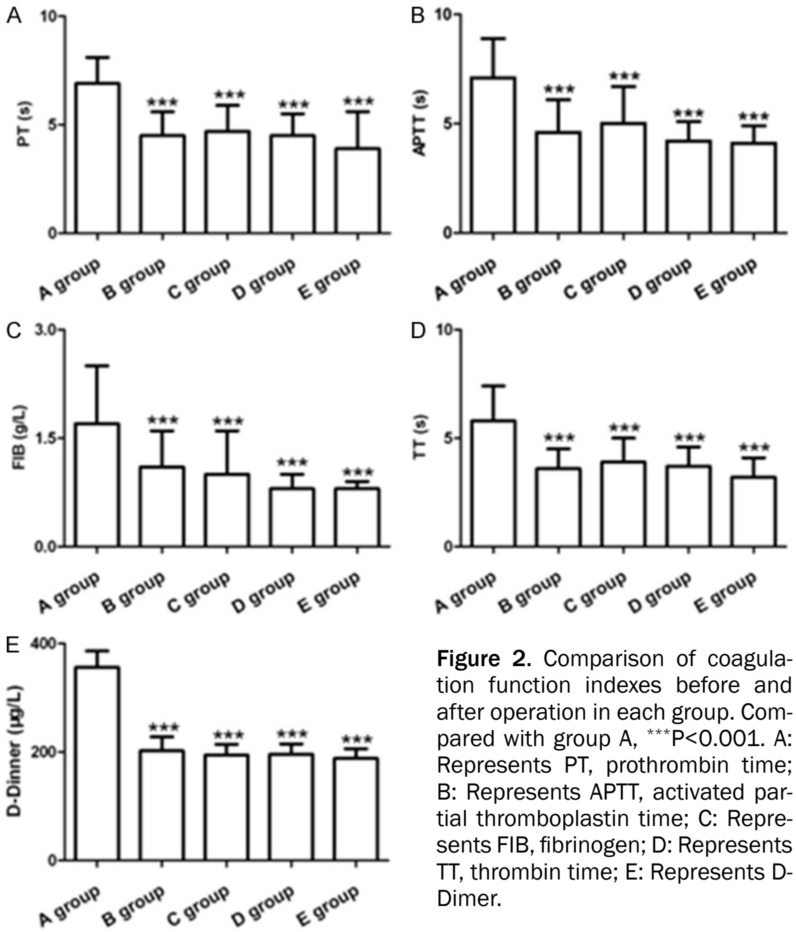

Figure 2. Comparison of coagulation function indexes before and after operation in each group. Compared with group A, ***P<0.001. A: Represents PT, prothrombin time; B: Represents APTT, activated partial thromboplastin time; C: Represents FIB, fibrinogen; D: Represents TT, thrombin time; E: Represents D-Dimer.

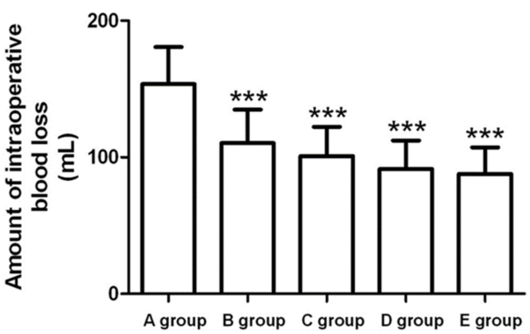

Figure 3. Comparison of intraoperative blood loss in each group. Compared with group A, the amount of intraoperative bleeding was significantly reduced in groups B, C, D and E; ***P<0.001.

tients' coagulation function parameters and completely monitors the process of blood clot formation. TEG parameters for detection include the K, R and MA values [27]. The K value is related to FIB, and its increase indicates insufficient fibrin function. The R value refers to the time required for the initial blood clot formation. Its increase indicates the lack of coagulation factors or the presence of anticoagulant, and its decrease indicates hypercoagulable state. The MA value directly reflects platelet function, and its changes are directly proportional to the platelet function. In the results of this study, the postoperative results of TEG in each group compared to the preoperative results showed that patients' coagulation function was significantly destroyed. There were statistically significant differences in the postoperative TEG parameters of patients between the groups B, C, D, E and the group A. Patients in the intravenous tranexamic acid groups had significantly lower R value than those in the control group, indicating that tranexamic acid applied in TKA has a significant protective effect on patients' coagulation factors. Patients in the intravenous tranexamic acid groups had significantly lower K value than those in the control group, indicating that tranexamic acid can significantly reduce the destruction of TKA in patients' FIB. Patients in the intravenous tranexamic acid groups had significantly higher MA value than those in the control group, indicating that tranexamic acid applied in TKA can protect platelets. There were no statistically significant differences in the K, R and MA values of patients among the groups B, C, D and E, indicating that there is no significant difference in protective effect on the coagulation system of patients undergoing TKA among different doses of tranexamic acid. In addition, in this study, five routine coagulation parameters of patients were also compared among the groups. The R value in TEG parameters corresponded to the PT, APTT and TT parameters in the coagulation function, the K value to the FIB and D-Dimer parameters. The results of this study showed that patients in the groups B, C, D and E had higher postop-

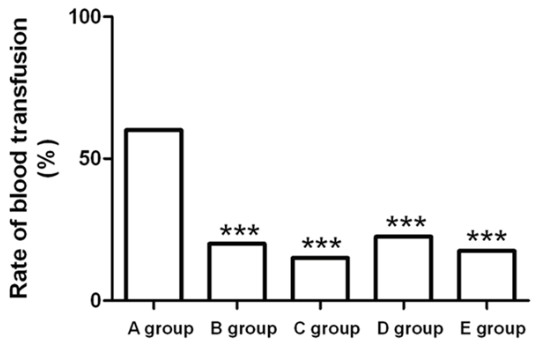

Figure 4. Comparison of postoperative transfusion rates in each group. Compared with group A, the transfusion rate was significantly reduced in groups B, C, D and E; ***P<0.001.

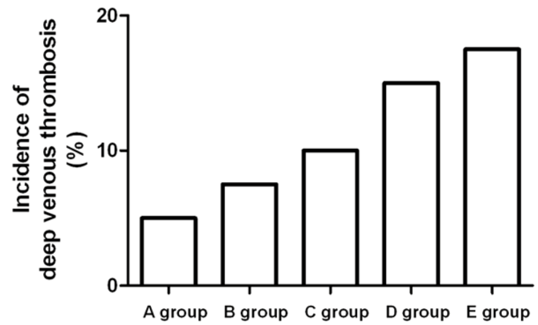

Figure 5. Comparison of deep venous thrombosis incidence in each group.

erative FIB than those in the group A, but lower postoperative PT, APTT, TT and D-Dimer than those in the group A. There were no statistically significant differences in the postoperative PT, FIB, APTT, TT and D-Dinner value of patients among the groups B, C, D and E. The detection of five parameters of routine coagulation in each group further confirmed changes in TEG parameters of them.

For the intravenous tranexamic acid, there have been few reports on the effects of its different doses on the intraoperative blood loss, postoperative blood transfusion rate and incidence of DVT of patients undergoing TKA [28]. The results of this study showed that patients in the groups B, C, D and E had significantly lower intraoperative blood loss and postoperative blood transfusion rate than those in the group A. This may be due to the fact that tranexamic acid causes plasminogen to lose its ability to bind to fibrin, thereby preventing fibrin degradation reaction and reducing blood loss. This is basically consistent with the research reports of Sadigursky et al. [29]. A previous study reported that the antifibrinolytic effect of tranexamic acid causes patients to be hypercoagulable, and TKA to patients' stress responses likely leads to DVT [30]. The results of this study showed that tranexamic acid groups had more cases of DVT than the control group, but there was no statistically significant difference in the incidence among the groups, indicating that the intravenous infusion of tranexamic acid does not increase the risk of developing DVT. This is similar to the report by Shen et al. [31]. However, this study has certain limitations such as small sample size and single-center study. In future researches, the sample size needed to be enlarged, and a multi-center randomized clinical experiment is needed to further confirm the conclusions.

In summary, tranexamic acid applied in TKA is beneficial to protect the coagulation system during the operation. There is no significant difference in the blood protection effect on patients undergoing TKA among 10 mg/kg, 15 mg/kg, 20 mg/kg and 30 mg/kg, so the lowest dose of 10 mg/kg is recommended.

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Disclosure of conflict of interest

None.

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