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Tranexamic acid reduces blood cost in long-segment spinal fusion surgery

A randomized controlled study protocol

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Abstract

Objective: Long-segment spinal fusion surgery was associated with substantial perioperative blood loss which may increase hospitalization expenses and mortality rates. Substantial studies have reported that tranexamic acid (TXA) could reduce blood products and cost after joint arthroplasty surgery. However, there still exists controversy regarding the efficacy of TXA in long-segment spinal fusion surgery. We performed this protocol to design a randomized controlled study to evaluate the efficacy of TXA in decreasing transfusion rate of allogeneic blood products and transfusion cost in degenerative lumbar scoliosis patients.

Methods: This study was carried out as a double-blinded, randomized clinical trial on patients with degenerative lumbar scoliosis who prepared for long-segment spinal fusion surgery from December 2018 to December 2019. It was authorized via the Institutional Review Committee in Southwest Medical University (ky2019225). Eighty patients were divided randomly into 2 groups (Experimental group = 40, control group = 40). The patients in the experimental group received 1000 mg of TXA mixed in 100 mL normal saline as a single dose intravenously over 20 minutes before the skin incision was made. Control group received equivalent normal saline without TXA. Primary outcomes included total blood loss, estimated intraoperative blood loss, hematocrit and hemoglobin decline, postoperative drain amount, intra-/postoperative allogeneic transfusion amount and rate, and total transfusion cost. Secondary outcomes included surgical time, thrombotic complications including deep vein thrombosis and pulmonary embolism. All the needed analyses were implemented through utilizing SPSS for Windows Version 20.0.

Results: Table showed the relevant clinical outcomes between experimental group and control group.

Conclusion: We hypothesized that TXA was effective and safe in reducing blood transfusion and cost in long-segment spinal fusion surgery.

Trial registration: This study protocol was registered in Research Registry (researchregistry5854).

Abbreviations: DLS = degenerative lumbar scoliosis, DVT = deep vein thrombosis, PE = pulmonary embolism, TXA = tranexamic acid.

Keywords: blood transfusion, cost, protocol, spinal fusion surgery, tranexamic acid

1. Introduction

Degenerative lumbar scoliosis (DLS) is defined as lumbar scoliosis, with a lumbar Cobb greater than 10°, developing primarily during adulthood without previous history of scoliosis.[1,2] It is reported that the incidence of DLS ranged from 2% to 70% in the patients aged more than 40 years.[3,4] With the development of technique, more and more patients receive surgical treatments. Decompression for neurological compromise combined with long level fusion and deformity correction could be considered during the surgery. However, the surgical procedure was associated with substantial perioperative blood loss which may increase hospitalization expenses and mortality rates, and allogeneic blood transfusion was frequently utilized to treat anemia.[5] As we all know that blood transfusion may cause many adverse effects including fever, virus infection, immunological transfusion reactions, hemolytic reaction, and acid–base imbalance.[6–8] Minimizing perioperative blood loss is important for improving surgical outcomes and promoting postoperative rehabilitation. Several strategies have been used to decrease blood loss, including minimally invasive surgery, autologous donation,

LY and XJ equally contributed to the study.

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The datasets generated during and/or analyzed during the current study are publicly available.

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intravenous hemostatic, and hypotensive anesthesia.[9] However, optimal strategy remains under debate.

Tranexamic acid (TXA), a lysine derivative with a structure similar to that of lysine, can be combined with lysine targets on the plasminogen and plasminogen to block the interaction between fibrin and heavy chain of plasmin, thus promoting the coagulation process and achieving the goal of controlling postoperative blood loss.[10,11] Substantial studies have reported that TXA could reduce blood products and cost after joint arthroplasty surgery.[12–14] However, there still exists controversy regarding the efficacy of TXA administration in long-segment spinal fusion surgery. Therefore, we performed this protocol to design a randomized controlled study to evaluate the efficacy of TXA in decreasing transfusion rate of allogeneic blood products and transfusion cost in DLS patients. We hypothesized that TXA was effective and safe in reducing blood cost in long-segment spinal fusion surgery.

2. Methods

2.1. Study design

This study was carried out as a double-blinded, randomized clinical trial on patients with degenerative lumbar scoliosis who prepared for long-segment spinal fusion surgery from December 2018 to December 2019. After obtained approval by the Ethics Committee of Southwest Medical University (ky2019225), we registered it in research registry (researchregistry5854).

2.2. Inclusion of exclusion criteria

The subjects in this research were 80 primary DLS patients from our Hospital. Patients undergoing posterior multilevel spinal fusion (≥5 vertebraes) would be included in the trial. The exclusion criteria were as follows: allergy to TXA; a history of deep vein thrombosis (DVT) or pulmonary embolism (PE) 3 months before the operation; patients with severe medical problems such as renal failure, coagulation disorders, and chronic heart failure.

2.3. Randomization and blinding

Eighty patients were divided randomly into 2 groups (Experimental group = 40, control group = 40). A table of random numbers hidden in the 1:1 ratio was computer-formed. A researcher who did not take part in the trial used the website Randomization.com to generate a random distribution sequence, which was hidden in sealed opaque sequence numbered envelopes that were allocated to investigators. The surgeons, investigator, anesthetist, and nurses were all kept blinded to allocation results.

2.4. Intervention

All patients received standard general anesthesia. After satisfactory anesthesia, all participants were placed in a prone position. The patients in the experimental group received 1000 mg of TXA mixed in 100 mL normal saline as a single dose intravenously over 20 minutes before the skin incision was made. Control group received equivalent normal saline without TXA. The senior authors performed meticulous exposure of the spine and posterior decompression fusion and fixation with the pedicle screw. Whether to perform the osteotomy and intervertebral fusion or not were decided by the surgeons according to the patients' radiological and clinical manifestation. After the pedicle screws were implanted by free-hand technique, neural decompression by laminectomy and discectomy was proceed. Smith-Peterson osteotomy, pedicle subtraction osteotomy, or even posterior vertebral column resection, if needed, were utilized. Then, a Cage with autogenous bone granules tamponade was placed into the appropriate intervertebral space. During the procedure of decompression, osteotomy, and fusion, surgeons carefully protected the neural elements. After rod assembly, posterolateral fusion was performed in all patients. Before wound closure, the bleeding was cautiously stanched, and negative suction subfascial drainage placed routinely. The administration standard of blood transfusion was hemoglobin value <70 g/L, or hemoglobin value was <80 g/L with anemia symptoms occurred.

2.5. Outcome measures

Postoperative clinical data were assessed by an independent senior surgeon blinded to the patient's randomization. Primary outcomes included total blood loss, estimated intraoperative blood loss, hematocrit and hemoglobin decline, postoperative drain amount, intra-/postoperative allogeneic transfusion amount and rate, and total transfusion cost. Total blood volume was projected by the Nadler formula, considering the gender of the patient, as shown below: Women: BV (l) = height $(m)^3 \times 0.3561$+weight (kg) $\times 0.03308 + 0.1833$. Men: BV (l) = height $(m)^3 \times 03669$+ weight (kg) $\times 0.03219 + 0.6041$. Total red blood cell loss = Total blood volume preop × (Hctpreop − Hctpostop). Total blood loss = Red blood cell loss/Hctpreop.[15] Secondary outcomes included surgical time, length of hospitalization, and thrombotic complications including DVT and PE.

2.6. Statistical analysis

The calculations of sample size are conducted utilizing the software of PASS 2011 (NCSS, LLC, Kaysville, UT). All the needed analyses are implemented through utilizing SPSS for Windows Version 20.0. Continuous outcomes are represented with proper characteristics as median, mean, as well as standard deviation. Categorical values are presented as frequency and percentage.

Mann–Whitney U test or the independent samples t test was used to analyze the intergroup comparison. χ^2 detection was utilized to compare the categorical variables among the groups. The analysis of repeated measurement of the variance was applied to analyze the repeated data. A $P < .05$ was regarded the significant in statistics.

3. Results

Table 1 showed the relevant clinical outcomes between experimental group and control group.

4. Discussion

To the best of our knowledge, this is the first randomized controlled trial to evaluate the efficacy and safety of intravenous TXA for reducing blood loss and transfusion cost in patients withlong-segment spinal fusion surgery. Minimizing blood loss in major orthopedic surgery is an interesting topic. The etiology of perioperative blood loss and transfusion during spine surgery is

Table 1

Shows the relevant clinical outcomes between experimental group and control group.

Variables	Tranexamic acid (n = 40)	Nontranexamic acid (n = 40)	*P* value
Total blood loss (mL)			
Estimated intraoperative blood loss (mL)			
Hemoglobin decline (g/L)			
Total drain amount (mL)			
Allogeneic transfusion amount (U)			
Total transfusion cost (USD)			
Surgical time (min)			
Length of hospitalization (d)			
Thrombotic complications (n)			

multifactorial. The number of intervertebral fusion, osteotomy procedure, preoperative physical condition, and age are independent predictors.[16,17] Because of a huge number of operations, elective surgery is often delayed due to a lack of blood products in hospital blood banks, which prolongs the length of hospital stay and increases medical cost. TXA has been proven to reduce perioperative blood loss and transfusion cost in various surgical procedures.[18,19] However, few study has reported the use of TXA in long-segment spinal fusion surgery. Thus, no consensus has been reached on the optimal regimen of the TXA delivery. In our study, all patients received intravenous TXA. Further research should focus on the topical or combined use of TXA. As an antifibrinolysis agent, thrombotic complications are also major concern when utilizing TXA in surgery. Long-tern follow-up is required.

5. Conclusion

We hypothesized that TXA was effective and safe in reducing blood transfusion and cost in long-segment spinal fusion surgery.

Author contributions

JK planned the study design. JY reviewed the protocol. XJ will collect data. LY wrote the manuscript. All authors approve the submission.

Data curation: XJ.

Visualization: JY.

Writing – original draft: LY.

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