

Use of Topical Tranexamic Acid in Reducing Postoperative Bleeding in Single Level Posterior Lumbar Spinal Fusion Surgery: A Quasi-Experimental Study

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HOW TO CITE:

Md. Mohiuddin Biswas, S.I.M. Khairun Nabi Khan, Sharmin Ferdous, Tanusree Burmon, Mohammad Imarat Hossain, Tofayel Ahmed, Razu Biswas, Abu Saleh Mohammad Abu Obaida (2026). Use of Topical Tranexamic Acid in Reducing Postoperative Bleeding in Single Level Posterior Lumbar Spinal Fusion Surgery: A Quasi-Experimental Study. International Journal of Special Education, 41(18s), 1451-1458

ABSTRACT:

Background: Lumbar spondylolisthesis, spinal canal stenosis and spinal instability causing back pain, radiculopathy and neurogenic claudication are very common in neurosurgical practice. Many of them require surgical decompression of neural element with spinal fusion and instrumentation. Spinal fusion surgery is frequently associated with significant blood loss leading to many problems. Use of antifibrinolytics as a strategy of blood loss management may alleviate these problems.

Objective: To compare and determine whether the topical application of tranexamic acid can reduce postoperative bleeding in single level posterior lumbar spinal fusion surgery. Methods: This quasi-experimental study included 30 participants (15 per group) undergoing single-level posterior lumbar spinal fusion at the Department of Neurosurgery, BSMMU, Dhaka. Data were collected after informed consent, and postoperative drain output and removal time were compared with or without topical tranexamic acid application before wound closure. Data were

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analyzed using SPSS version 26 and presented as frequency, percentage, and mean (SD). Chi-square/Fisher's exact tests and Wilcoxon rank-sum test were used, with $p < 0.05$ considered statistically significant.

Results: In this study, the sociodemographic and clinical characteristics were identical between the study and control group. The study group demonstrated statistically significant reduction of postoperative drain collection following single level posterior lumbar spinal fusion surgery (p -value < 0.001) and was associated with earlier drain removal which was also statistically significant (p -value 0.002).

Conclusion: Topical application of tranexamic acid significantly reduces postoperative bleeding in single level lumbar spinal fusion surgery, as evidenced by a 17% lower total drain output and earlier drain removal.

Keywords: Topical Tranexamic Acid, Postoperative Bleeding, Single Level Posterior Lumbar Spinal Fusion Surgery, Lumbar spondylolisthesis.

INTRODUCTION:

Lumbar spondylolisthesis, spinal canal stenosis, and instability might need decompression combined with fusion and instrumentation following unsuccessful conservative management. Nonetheless, surgical exposure, preparation of the bone, and abundant spinal vascularity lead to considerable perioperative blood loss, with severe bleeding noted in approximately 14% of instances [1-5].

Blood loss during the perioperative period can reduce surgical visibility, extend operation duration, and elevate the risks of hypovolemia, organ hypoperfusion, coagulopathy, infection, and epidural hematoma. It can lead to postoperative anemia that necessitates transfusion, which involves risks of transfusion reactions, infections, higher expenses, and extended hospital stays [5-10]. Various blood conservation techniques, including hemodilution, blood salvage, hypotensive anesthesia, electrocautery, and hemostatic agents, are used to reduce blood loss; however, transfusion is still often required. Antifibrinolytic agents have gained popularity as an effective strategy for blood loss management [4,8]. Tranexamic acid is a synthetic lysine

analogue that inhibits fibrinolysis by competitively and reversibly binding to lysine binding sites on plasminogen, plasmin, and tissue plasminogen activator, reducing plasmin formation and fibrin degradation, thereby decreasing bleeding [2,4,10,11].

Tranexamic acid can be administered orally, intravenously, or topically. It has rapid absorption, 100% intravenous bioavailability, a 1–3 hour half-life, minimal hepatic metabolism, and renal excretion with wide tissue distribution [11]. Intravenous tranexamic acid (TXA) is widely used in cardiac, orthopedic, trauma, and spine surgeries but may rarely cause systemic complications such as DVT, pulmonary embolism, myocardial infarction, stroke, and seizures [2,12-14].

Topical TXA application at the surgical site provides high local concentration with minimal systemic absorption, reducing blood loss and the risk of systemic complications compared with intravenous administration [15,8,7]. In many studies, intravenous tranexamic acid reduces blood loss and allogenic blood transfusion in spinal surgery without serious complication, but there is still no consensus for its topical use in spinal fusion surgery [8,13]. Topical tranexamic acid

demonstrate clinical efficacy in postoperative blood loss, reduces need for allogenic blood transfusion, decrease length of hospital stay and adverse events in respect to intravenous administration^[15].

Evidence on the use of topical tranexamic acid for reducing postoperative bleeding after single-level posterior lumbar spinal fusion surgery is limited in Bangladesh. Therefore, this study aimed to evaluate its effectiveness in reducing drain output and improving drain removal time after lumbar spinal fusion surgery.

MATERIALS AND METHODS:

Study design: This quasi-experimental study was conducted in the Department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University (BSMMU), Shahbag, Dhaka, over a two-year period from September 2022 to October 2024.

Study population: The study population included all participants who underwent single level posterior lumbar spinal fusion surgery in Department of Neurosurgery, BSMMU fulfilling the selection criteria.

Sample size: Participants were selected using purposive sampling based on the availability of eligible patients who fulfilled the predefined selection criteria. A total of 30 participants were enrolled, with 15 participants allocated to the study group and 15 to the control group.

Selection criteria:

Inclusion Criteria:

Subject who underwent single level posterior lumbar spinal fusion surgery in Neurosurgery department of BSMMU.

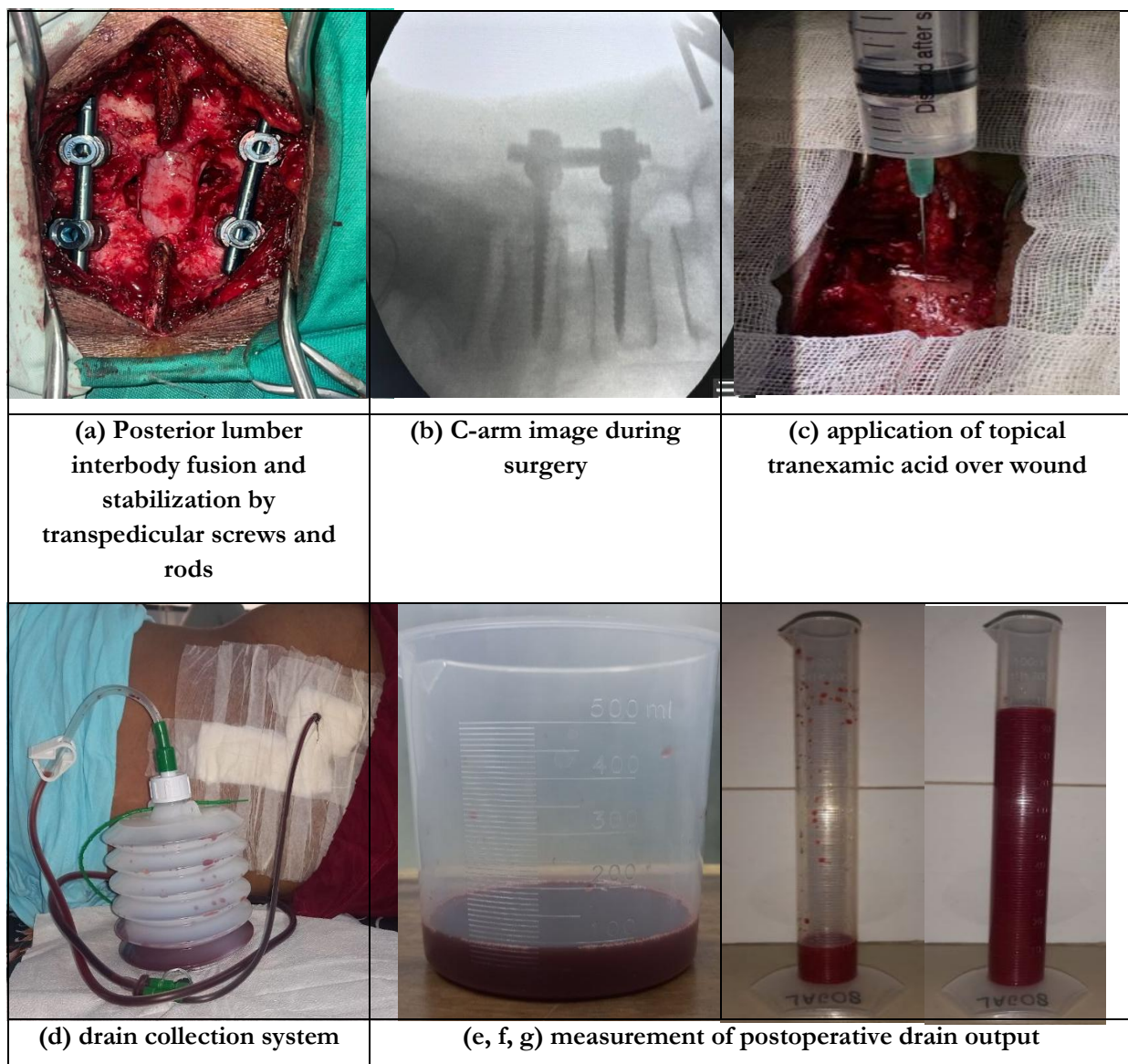
Exclusion Criteria:

- Low platelet count <1,00,000/cc
- Antiplatelet medication
- Bleeding disorder, abnormal coagulation profile
- Previous history of thromboembolic episode (PE, DVT)
- Stroke, Hepatorenal, Cardiopulmonary dysfunction
- Allergy to tranexamic acid
- Peroperative dural tear
- Prior spinal fusion surgery

Study procedure: Participants in both groups underwent posterior lumbar decompression, pedicle screw fixation, and interbody fusion under general anesthesia in the prone position on a Relton–Hall frame. Following skin preparation, spinal exposure, pedicle screw and rod fixation, laminectomy, discectomy, endplate preparation, and interbody fusion using autologous bone graft, hemostasis was achieved with bipolar electrocautery.

In the study group, 1 g of tranexamic acid diluted with 10 mL normal saline to a total volume of 20 mL was instilled into the surgical wound and retained for 5 minutes before layered wound closure with placement of a subfascial closed suction drain. In the control group, an identical procedure was performed except that 20 mL of normal saline was instilled instead of tranexamic acid. Postoperatively, drain output was measured in milliliters at the 3rd, 24th, 48th, 72nd, and 96th hours, and the total drain output was recorded. The drain was removed when the output during the preceding 24 hours was less than 30 mL, and the postoperative day (POD) of drain removal was documented.

Figure I: Surgical steps and measurement of drain collection



Data collection procedure: The study was conducted in the Department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University (BSMMU), where eligible participants were recruited from the inpatient department following primary screening based on the predefined inclusion and exclusion criteria. After explaining the purpose of the study, informed written consent was obtained from all participants and/or their legal guardians or responsible family members. Data were collected using a structured data collection sheet. A detailed clinical history was obtained, followed by general and neurological examinations. All participants underwent MRI of the lumbosacral spine and standing lateral flexion-extension X-rays of the lumbosacral

spine, which were interpreted by a radiologist, and the diagnosis was confirmed clinically and radiologically. Participants were purposively allocated to the study and control groups and subsequently underwent instrumented single-level posterior lumbar spinal fusion surgery. The study group received topical tranexamic acid, whereas the control group received normal saline. Postoperatively, drain output was measured in milliliters, and the postoperative day (POD) of drain removal was also recorded.

Statistical analysis: After checking for completeness and consistency, data were analyzed using SPSS version 26. Results were presented as frequencies, percentages, and mean $\pm$ SD using appropriate tables and charts.

Qualitative variables were analyzed using the Chi-square or Fisher's exact test, quantitative variables using the Wilcoxon rank-sum test, and a p-value <0.05 was considered statistically significant.

Ethical considerations: Ethical approval was obtained from the Department of Neurosurgery and IRB of Bangabandhu Sheikh Mujib Medical University. Written informed consent was taken after explaining the study details, and confidentiality, privacy, and participants' right to withdraw were ensured. The study was conducted according to the Helsinki Declaration.

RESULTS:

Table 1 presents the fundamental demographic attributes of the participants. The average age was 50.73 ± 9.50 years in the study group and 49.63 ± 9.11 years in the control group, with the majority of participants being between 41 and 60 years old. In the study group, males made up the majority (60.0%), while females constituted the majority in the control group (66.7%). The average BMI was similar in both the study and control groups (25.27 ± 4.48 vs. 25.07 ± 4.56 kg/m²). There were no statistically significant differences between the groups in terms of age ($p = 0.60$), sex ($p = 0.14$), or BMI ($p > 0.90$), which suggests similar baseline characteristics.

Table 1: Baseline demographic characteristics of the participants (n = 30)

Variable	Study group (n=15)	Control group (n=15)	p value
Age group, n (%)			
31–40 years	3 (20.0)	4 (26.7)	
41–50 years	5 (33.3)	5 (33.3)	
51–60 years	6 (40.0)	5 (33.3)	
61–70 years	1 (6.7)	1 (6.7)	
Age range (min–max), years	36–66	35–70	
Age (years), Mean $\pm$ SD	50.73 ± 9.50	49.63 ± 9.11	0.60 ^a
Sex, n (%)			0.14 ^b
Male	9 (60.0)	5 (33.3)	
Female	6 (40.0)	10 (66.7)	
BMI (kg/m²), Mean $\pm$ SD	25.27 ± 4.48	25.07 ± 4.56	>0.90 ^a

Table 2 presents the allocation of participants based on clinico-radiological diagnosis and Meyerding classification of spondylolisthesis. The main diagnosis in both the study (93.33%) and control (86.67%) groups was L4 over L5 vertebrae spondylolisthesis, whereas L3 over L4 spondylolisthesis occurred less often. Grade I Meyerding spondylolisthesis was the most

prevalent grade, seen in 80.0% of the study group and 73.33% of the control group, while Grade II was present in 20.0% and 26.67% of participants, respectively. No statistically significant differences were found between the groups concerning clinico-radiological diagnosis or Meyerding grading ($p > 0.90$ for both).

Table 2: Distribution of participants according to clinico-radiological diagnosis and Meyerding grading of spondylolisthesis (n = 30)

Variable	Study group (n=15)	Control group (n=15)	p value
Clinico-radiological diagnosis, n (%)			>0.90 ^a
Spondylolisthesis of L3 over L4 vertebrae	1 (6.67)	2 (13.33)	
Spondylolisthesis of L4 over L5 vertebrae	14 (93.33)	13 (86.67)	
Meyerding grading, n (%)			>0.90 ^a
Grade I	12 (80.00)	11 (73.33)	
Grade II	3 (20.00)	4 (26.67)	

Table 3 contrasts the postoperative drainage output of the study group with that of the control group. Drain output was markedly reduced in the study group at the 3rd hour (14.53 ± 1.92 vs. 23.27 ± 3.15 mL, $p < 0.001$), 24th hour (97.60 ± 3.70 vs. 103.40 ± 7.01 mL, $p = 0.035$), 48th hour (73.93 ± 4.67 vs. 79.93 ± 6.30 mL, $p = 0.009$), and 72nd hour ($29.40 \pm$

9.57 vs. 41.13 ± 9.36 mL, $p = 0.002$). At the 96th hour, the output from drainage was similar across the groups (26.67 ± 1.53 vs. 24.82 ± 1.99 mL, $p = 0.156$). In general, the overall postoperative drain output was considerably reduced in the study group compared to the control group (220.80 ± 17.28 vs. 265.93 ± 23.60 mL, $p < 0.001$).

Table 3: Comparison of postoperative drain output between the study and control groups (n = 30)

Postoperative time	Study group (n = 15) Mean $\pm$ SD (mL)	Control group (n = 15) Mean $\pm$ SD (mL)	p value ^a
3rd hour	14.53 ± 1.92	23.27 ± 3.15	<0.001
24th hour (POD 1)	97.60 ± 3.70	103.40 ± 7.01	0.035
48th hour (POD 2)	73.93 ± 4.67	79.93 ± 6.30	0.009
72nd hour (POD 3)	29.40 ± 9.57	41.13 ± 9.36	0.002
96th hour (POD 4)	26.67 ± 1.53	24.82 ± 1.99	0.156
Total drain output	220.80 ± 17.28	265.93 ± 23.60	<0.001

Table 4 reveals the difference of total drain output between control and study group. The total amount of drain output over the postoperative period was significantly higher in the

control group (265.93 ± 23.60 ml) compared to the study group (220.80 ± 17.28 ml) with difference about 45.13. It also showed 17% reduction of drain output in study group.

Table 4: Comparison of total postoperative drain output and percentage reduction between the study and control groups (n = 30)

Parameter	Control group (n = 15) Mean $\pm$ SD (mL)	Study group (n = 15) Mean $\pm$ SD (mL)	Mean difference (mL)	Percentage reduction
Total drain output	265.93 ± 23.60	220.80 ± 17.28	45.13	17.0%

Table 5 compares the drain removal time (POD) between the study and control groups. On 3rd POD, 80% (12) of the participants in the study group had their drains removed, compared to only 26.67% (4) in the control group. Conversely, on 4th POD, 20% (3) of participants

in the study group had their drains removed, compared to 73.33% (11) in the control group. The mean drain removal time in study group was 3.20 ± 0.41 day and in control group 3.73 ± 0.46 days which was statistically significant (p -value = 0.002).

Table 5: Comparison of drain removal time between the study and control groups (n = 30)

Drain removal time	Study group (n = 15)	Control group (n = 15)	p value ^a
Drain removal day, n (%)			
POD 3	12 (80.0)	4 (26.7)	
POD 4	3 (20.0)	11 (73.3)	
Drain removal time (days), Mean $\pm$ SD	3.20 $\pm$ 0.41	3.73 $\pm$ 0.46	0.002

DISCUSSION:

The demographic analysis showed no significant differences in age, sex, or BMI between the study and control groups. The mean age was 50.73 ± 9.50 years in the study group and 49.63 ± 9.11 years in the control group ($p=0.60$). Similar baseline characteristics were reported in a previous elective spine surgery study. The comparable distribution of sex ($p=0.14$) and BMI ($p>0.90$) indicates that the groups were well matched, reducing the possibility of bias from demographic factors and supporting reliable comparison of treatment outcomes [2]. The present study found that L4 over L5 was the most common level of spondylolisthesis in both study (93.33%) and control (86.67%) groups. A previous study also reported L4–L5 as the predominant level of spondylolisthesis in both groups (63.4% and 65.3%). Degenerative spondylolisthesis commonly occurs at L4–L5, while isthmic spondylolisthesis is more frequent at L5–S1. Most participants had Grade I or II spondylolisthesis according to the Meyerding classification, with no Grade III or IV cases, indicating comparable disease severity between groups and reducing potential outcome bias [6,13,16–18]. Drain output was significantly lower in the topical tranexamic acid group compared to the control group (220.80 ± 17.28 ml vs. 265.93 ± 23.60 ml, $p<0.001$), indicating reduced postoperative bleeding. Similar findings were reported by Shakeri et al. (2021), with lower mean postoperative bleeding in the tranexamic acid group (217.25 ± 59.00 ml) compared to control (243.25 ± 63.82 ml). Ren et al. (2017) also demonstrated reduced blood loss with tranexamic acid (155.20 ± 104.30 ml vs. 278.60 ± 124.10 ml), supporting its effectiveness in minimizing postoperative bleeding.

Topical tranexamic acid reduced total drain output by 17% compared with the control group (220.80 ± 17.28 ml vs. 265.93 ± 23.60 ml), indicating effective reduction of postoperative bleeding. Similar findings were reported with intravenous tranexamic acid, showing significant blood loss reduction in spinal surgery [8]. Topical application may provide comparable bleeding control with fewer systemic risks, including thromboembolic complications [15]. Drain removal was significantly earlier in the tranexamic acid group than the control group (3.20 ± 0.41 vs. 3.73 ± 0.46 days, $p=0.002$), suggesting improved postoperative recovery. Similar findings were reported by Sudaprest et al. (2019), with drain removal at 2.8 ± 0.9 and 3.2 ± 0.8 days, respectively [4,5]; also observed earlier drain removal with tranexamic acid (2.0 ± 0.6 vs. 2.4 ± 0.5 days), supporting its role in reducing postoperative bleeding and facilitating recovery. This study suggests that topical tranexamic acid may be a valuable component in lumbar spinal fusion surgery by effectively reducing blood loss, improving recovery, and minimizing risks associated with systemic antifibrinolytic use.

CONCLUSION:

This study demonstrated that topical tranexamic acid significantly reduces postoperative bleeding in single level lumbar spinal fusion, as evidenced by a 17% lower total drain output and earlier drain removal. These findings support the application of topical tranexamic acid into standard surgical practice for effective blood loss management, enhancing patient recovery and safety. The results provide a strong foundation for further research to optimize tranexamic acid use in spinal surgery and explore its broader applications. Overall, the

study highlights the clinical value of topical tranexamic acid in improving surgical outcomes.

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