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Original Research Article

Comparison of Different Tranexamic Acid Doses in Minimizing Blood Loss and Transfusion Requirements during Spine Surgeries

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Abstract:

Introduction: Spinal surgeries often involve significant blood loss due to extensive dissection and vascularized bone exposure, leading to postoperative anaemia, increased transfusion requirements, and heightened infection risk. Tranexamic acid (TXA), an antifibrinolytic agent, has proven efficacy in reducing perioperative blood loss across surgical disciplines. However, optimal dosing in spine surgeries remains unclear. This study evaluates the effectiveness and safety of varying TXA doses (10 mg/kg, 15 mg/kg, and 20 mg/kg) in minimizing intraoperative and postoperative blood loss and transfusion needs.

Materials and Methods: A prospective, randomised study was conducted at Mamata Medical College, Telangana, involving 75 patients undergoing elective spine surgeries. Participants were assigned to receive TXA intravenously at 10 mg/kg, 15 mg/kg, or 20 mg/kg. Blood loss was measured intraoperatively and postoperatively (24 hours), while transfusion requirements, hemodynamic parameters, and adverse events were recorded. Statistical analysis included ANOVA and chi-square tests, with a significance threshold of $p < 0.05$.

Results: Group C (20 mg/kg) demonstrated the least intraoperative (350 ± 30 mL) and postoperative blood loss (150 ± 10 mL), compared to Groups A (650 ± 50 mL, 300 ± 20 mL) and B (480 ± 40 mL, 220 ± 15 mL) ($p < 0.05$). Transfusion requirements were significantly lower in Group C (4 patients) than in Groups A (16) and B (10) ($p = 0.002$). No major thromboembolic events were observed.

Conclusion: A TXA dose of 20 mg/kg effectively minimizes blood loss and transfusion needs during spine surgeries without increasing adverse events, supporting its use for optimal perioperative blood conservation.

Keywords: Tranexamic acid, spine surgery, blood loss minimisation.

Introduction

Spinal procedures are inherently intricate and often linked to considerable blood loss due to extensive tissue dissection, extended operational durations, and exposure to vascularised bone surfaces. [1] This significant intraoperative blood loss may result in problems including postoperative anaemia, transfusion-related adverse responses, heightened infection risk, and prolonged hospital stays. [2] [3] Implementing blood conservation methods is essential to alleviate these hazards. [4]

Tranexamic acid (TXA) has become prominent among pharmacological treatments for minimising perioperative blood loss due to its antifibrinolytic effects. [5] TXA competitively inhibits the activation of plasminogen, thereby diminishing fibrinolysis and reinforcing blood clots. [6] Its effectiveness in reducing blood loss has been firmly proven across various surgical specialities, including cardiac, orthopaedic, and trauma procedures. [7] Despite comprehensive research, a consensus on the ideal dose regimen of TXA for spine surgeries, which are especially susceptible to significant bleeding due to their procedural nature, remains elusive. [8][9] Various dosages and administration methods have been investigated, encompassing low-dose continuous infusions to high-dose bolus regimens. Nonetheless, discrepancies in study methodologies, surgical approaches, and patient demographics have led to contradictory guidelines.

Considering the therapeutic importance of minimising perioperative blood loss and the accompanying hazards of transfusions, it is essential to assess the most effective dosage techniques for TXA during spinal procedures. This study evaluates the efficacy and safety of different

TXA dosing regimens in reducing intraoperative and postoperative blood loss, lowering transfusion needs, and safeguarding patient safety during spinal procedures. The results will enhance perioperative care and create consistent dose protocols for TXA in spinal surgical procedures.

Materials and Methods

This prospective, randomised study was conducted in the Department of Anaesthesia at Mamata Medical College, Khammam, Telangana, from July 2023 to July 2024. The study included 75 patients undergoing elective spine surgeries, divided into three groups of 25 each, based on the dose of tranexamic acid administered. Inclusion criteria were patients aged 30 years and above, undergoing single-level or multilevel spinal surgeries, and classified as ASA grade I or II. Patients with a history of thromboembolic events, coagulopathy, or hypersensitivity to tranexamic acid were excluded. Patients were randomised to receive a bolus dose of tranexamic acid of either 10 mg/kg (Group A), 15 mg/kg (Group B), or 20 mg/kg (Group C) intravenously, administered 10 minutes before skin incision. Standardised anaesthetic protocols were followed for all patients. Intraoperative blood loss was measured using calibrated suction canisters and weighing surgical sponges, and postoperative blood loss was monitored via drainage output for 24 hours. Hemodynamic parameters, transfusion requirements, and any adverse events were also recorded.

Statistical analysis was performed using SPSS software version 25. Continuous variables were analysed using ANOVA for comparisons among the three groups, while categorical data were compared using the chi-square test.

A p-value < 0.05 was considered statistically significant. Ethical approval was obtained from the institutional ethics committee, and informed consent was obtained from all participants.

Results

The demographic profile of the patients showed no significant differences among the three groups, ensuring comparability. The mean age of participants was 45 ± 10 years, 47 ± 12 years, and 46 ± 11 years for Groups A, B, and C, respectively. The male-to-female ratio and ASA classifications were also similar across groups. (Table 1)

Table 1: Demographic Details

Parameter	Group A (10 mg/kg)	Group B (15 mg/kg)	Group C (20 mg/kg)
Age (mean ± SD)	45 ± 10	47 ± 12	46 ± 11
Male: Female ratio	15:10	16:9	14:11
ASA I: II	18:7	19:6	20:5

The mean intraoperative blood loss was significantly lower in Group C (20 mg/kg) compared to Group A (10 mg/kg) and Group B (15 mg/kg). The average blood loss was 650 ± 50 mL in Group A, 480 ± 40 mL in Group B, and 350 ± 30 mL in Group C (p=0.021). Postoperative blood loss within 24 hours followed a similar trend, with Group C showing the least loss at 150 ± 10 mL compared to 300 ± 20 mL in Group A and 220 ± 15 mL in Group B (p=0.038).

Table 2: Blood Loss and Transfusion Requirements

Parameter	Group A (10 mg/kg)	Group B (15 mg/kg)	Group C (20 mg/kg)	p-value
Intraoperative blood loss (mL)	650 ± 50	480 ± 40	350 ± 30	0.021
Postoperative blood loss (mL)	300 ± 20	150 ± 10	220 ± 15	0.038
Patients requiring transfusion	16	10	4	0.002

The requirement for blood transfusion was also significantly reduced in Group C. In Group A, 16 patients required transfusion; in Group B and Group C, the numbers were 10 and 4, respectively ($p = 0.002$). Hemodynamic parameters remained stable across all groups, with no significant intergroup differences.

No major thromboembolic events or adverse reactions to tranexamic acid were observed in any group. Group C (20 mg/kg bolus dose) demonstrated superior efficacy in minimising blood loss and reducing transfusion requirements during and after spine surgeries, with no increase in adverse events. These findings support using a higher tranexamic acid dose for optimal blood conservation in such procedures.

Discussion

The current study evaluated the impact of three different doses of tranexamic acid (TXA) 10 mg/kg, 15 mg/kg, and 20 mg/kg—on intraoperative and postoperative blood loss and transfusion requirements during spine surgeries.

Our findings demonstrate a clear dose-dependent effect of TXA, with the highest dose (20 mg/kg) significantly reducing intraoperative and

postoperative blood loss while minimising transfusion needs. These results align with several previously published studies supporting the safety and efficacy of higher TXA dosing in spinal surgeries.

Our results revealed a substantial reduction in intraoperative blood loss in the 20 mg/kg group (350 ± 30 mL), compared to 480 ± 40 mL in the 15 mg/kg group and 650 ± 50 mL in the 10 mg/kg group. This finding supports the meta-analysis by Cao Z et al. [10], who reported that high-dose TXA regimens are superior in minimising intraoperative blood loss. Additionally, Verma et al. highlighted that a 20 mg/kg TXA loading dose followed by continuous infusion produced significantly lower blood loss than standard or low-dose regimens. Similarly, the systematic review by Rahmani A et al. [11] concluded that TXA administration significantly reduces intraoperative bleeding by inhibiting fibrinolysis during surgery, consistent with our observations.

Postoperative drainage within 24 hours followed a similar trend, with the 20 mg/kg group showing the least blood loss (150 ± 10 mL), compared to 220 ± 15 mL in the 15 mg/kg group and 300 ± 20 mL in the 10 mg/kg group. This reduction may be attributed to sustained inhibition of fibrinolysis postoperatively. Todeschini AB et al. [12] also reported that TXA effectively reduced intraoperative and postoperative bleeding in multilevel spinal fusion procedures, aligning with our findings. Yoo JS et al. [7] further suggested extending TXA administration beyond the intraoperative period might enhance postoperative outcomes, reducing drainage output and transfusion needs.

A critical observation in our study was the dose-dependent reduction in transfusion requirements. Only 4 patients in the 20 mg/kg group required transfusions, compared to 10 in the 15 mg/kg group and 16 in the 10 mg/kg group. This statistically significant difference underscores the role of higher TXA doses in preserving perioperative haemoglobin levels and minimising the need for transfusions. The findings are aligned with previous research by Kanhangad MP et al. [1], who reported fewer transfusions in patients receiving high-dose TXA in open spine surgeries. Similarly, the retrospective study by Ramakrishnan A et al. [11] found that a high TXA dose reduced transfusion volumes by nearly 50% compared to standard doses in adolescent scoliosis correction surgeries. Cao Z et al. [10] further emphasised that higher TXA doses reduce transfusion rates through more effective inhibition of fibrin degradation, thereby preserving clot stability during and after surgery. This mechanism likely explains the improved clinical outcomes observed in our study.

Despite concerns about potential thromboembolic complications associated with high-dose TXA, no major adverse events were observed in our study. This finding is consistent with several large-scale meta-analyses, including the studies by Li ZJ et al. [13] and Verma et al. [14], which reported no increase in thrombotic events even with doses exceeding 20 mg/kg.

Cao et al. confirmed the overall safety of high-dose TXA, emphasising its favourable risk-benefit profile in major spine surgeries. Our study's absence of adverse events highlights the importance of careful patient selection and monitoring, as described by various clinical trials assessing TXA's safety in orthopaedic and spinal procedures.

The findings of our study align closely with previous research while offering additional insights into the dose-dependent efficacy of tranexamic acid (TXA) in reducing blood loss during spine surgeries. Meta-analyses conducted by Li ZJ et al. [13] and Cao Z et al. [10] underscored the effectiveness of TXA in minimising intraoperative blood loss and reducing transfusion requirements. Both studies highlighted the importance of dosing, emphasising that higher doses yield better hemostatic control. However, they also recommended further randomised controlled trials to establish standardised dosing protocols.

Several clinical trials have reported outcomes similar to ours, particularly regarding TXA doses of 20 mg/kg or higher. These studies demonstrated that higher doses of TXA effectively control intraoperative and postoperative bleeding without increasing the risk of thrombotic events. This supports the safety and efficacy profile observed in our study, where no adverse thromboembolic events were detected, even with the highest TXA dose.

Retrospective analysis by Todeschini AB et al. [12] and Ramakrishnan A et al. [11] further reinforce the potential of high-dose TXA in reducing transfusion requirements and overall blood loss. These studies, focusing on complex spine surgeries, found that higher TXA doses resulted in substantial reductions in intraoperative bleeding and postoperative drainage, consistent with our findings. Their data strengthen the argument for integrating high-dose TXA into clinical protocols for managing significant perioperative blood loss.

Our study strongly supports the routine administration of a 20 mg/kg TXA dose in complex spine surgeries. The demonstrated reduction in intraoperative and postoperative blood loss and decreased transfusion requirements highlights the dose’s clinical efficacy and potential to improve surgical outcomes. However, personalised TXA administration based on individual patient

characteristics—such as age, comorbid conditions, and surgical complexity—remains critical to optimising treatment.

Future research should prioritise large-scale, multicenter randomised controlled trials comparing high-dose TXA regimens. This would help refine dosing protocols, ensuring optimal blood conservation while minimising risks. Studies exploring the timing, infusion rates, and combined administration routes (intravenous and topical) could further enhance the drug's effectiveness.

Another critical area for future research is investigating the long-term safety profile of repeated high-dose TXA use in spine surgeries. Understanding potential cumulative effects would aid in establishing comprehensive guidelines for safe and effective perioperative TXA administration. These efforts will help maximise TXA's benefits in reducing blood loss and transfusion requirements while maintaining patient safety.

Conclusion

In conclusion, our study confirms that a TXA dose of 20 mg/kg significantly reduces intraoperative and postoperative blood loss and minimises transfusion requirements without increasing thrombotic complications. These findings align with and reinforce the current body of evidence supporting high-dose TXA in spinal surgeries. Implementing this dosing strategy could substantially improve surgical outcomes, reduce hospital stays, and lower healthcare costs for spine surgery patients. Further large-scale prospective studies are warranted to standardise TXA dosing protocols in clinical practice.

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