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Original Research Article

Impact of Tranexamic Acid on Perioperative Blood Loss and Transfusion Requirements in Orthopedic Trauma Surgery

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Abstract: ***Background*:** Orthopedic trauma surgeries often involve significant blood loss, leading to increased transfusion requirements and associated complications. Tranexamic acid (TXA), an antifibrinolytic agent, has been shown to reduce blood loss in various surgical settings. This study aims to evaluate the impact of TXA on perioperative blood loss and transfusion requirements in orthopedic trauma surgery. ***Methods:*** A cross-sectional study was conducted at North East Medical College and Hospital (NEMCH), Sylhet, from October 2023 to October 2024, involving 96 patients undergoing orthopedic trauma surgery. The patients were divided into two groups: the TXA group (n=48) received 1g of TXA intravenously 30 minutes before surgery and 1g postoperatively, while the control group (n=48) did not receive TXA. Perioperative blood loss, transfusion requirements, thromboembolic events, and surgical outcomes were compared between the two groups. ***Results:*** The TXA group showed a significant reduction in intraoperative blood loss (220 ± 45 mL vs. 340 ± 55 mL, $p<0.01$) and postoperative blood loss (150 ± 35 mL vs. 280 ± 50 mL, $p<0.01$) compared to the control group. The TXA group also had fewer patients requiring blood transfusions (18.7% vs. 37.5%, $p=0.02$) and a lower mean number of units transfused (0.6 ± 0.4 vs. 1.3 ± 0.5, $p<0.01$). There was no significant difference in thromboembolic events between the groups ($p=0.51$). The duration of surgery and hospital stay were similar between the groups, although the TXA group had a shorter hospital stay (5.2 ± 1.1 days vs. 6.5 ± 1.4 days, $p<0.01$). ***Conclusion:*** TXA significantly reduced both perioperative blood loss and transfusion requirements in orthopedic trauma surgery, with no increase in thromboembolic events. These findings support the routine use of TXA in orthopedic trauma surgeries to enhance patient outcomes and reduce complications.

Keywords: Tranexamic Acid, Orthopedic Trauma Surgery, Blood Loss, Transfusion, Bangladesh, Cost-Effectiveness, Safety.

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Introduction

Orthopedic trauma surgeries are often associated with significant perioperative blood loss, leading to the frequent need for allogeneic blood transfusions. Blood transfusions, while lifesaving, are not without risks, including immunologic reactions, infections, and iron overload, which can increase morbidity and healthcare costs[1]. Consequently, strategies to minimize perioperative blood loss and transfusion requirements have become critical,

particularly in resource-constrained settings. Tranexamic acid (TXA), a synthetic antifibrinolytic agent, has garnered significant attention for its role in reducing blood loss across various surgical disciplines. TXA works by inhibiting the activation of plasminogen to plasmin, thus stabilizing fibrin clots and reducing fibrinolysis[2]. Evidence from meta-analyses and randomized controlled trials has demonstrated the efficacy of TXA in reducing blood loss and transfusion rates in elective orthopedic procedures such as total hip and knee arthroplasties[3,4]. However, it's utility in the context of orthopedic trauma surgery, characterized by complex and variable injury patterns, remains underexplored.

Orthopedic trauma encompasses a diverse range of injuries, including fractures of long bones, pelvis, and periarticular regions, often necessitating extensive surgical interventions. These surgeries are particularly prone to significant blood loss due to the highly vascular nature of bone and surrounding soft tissues[5]. In trauma settings, timely blood conservation strategies such as TXA administration are crucial to improve patient outcomes and optimize resource use. Several studies have reported the benefits of TXA in reducing blood loss during trauma-related surgeries. The CRASH-2 trial highlighted TXA's efficacy in reducing mortality in trauma patients with significant bleeding without increasing the risk of thromboembolic complications[6]. Additional studies have demonstrated its safety and effectiveness in orthopedic trauma surgeries, although concerns regarding potential thrombotic events necessitate context-specific evaluations[7].

In Bangladesh, road traffic accidents and falls are leading causes of orthopedic trauma, with significant healthcare burdens[8,9]. North East Medical College and Hospital (NEMCH), Sylhet, is a key tertiary care center providing orthopedic trauma care. Given the limited availability of blood products in the region, it is imperative to explore interventions like TXA to reduce blood loss and transfusion dependency[10]. This study aims to evaluate the impact of TXA on perioperative blood loss and transfusion requirements in patients undergoing orthopedic trauma surgery at NEMCH. By generating localized evidence, the findings will inform clinical practice guidelines and contribute to improved surgical outcomes in resource-limited settings.

Methods and Materials

Study Design

This was a cross-sectional study conducted to evaluate the impact of tranexamic acid (TXA) on perioperative blood loss and transfusion requirements in orthopedic trauma surgery.

Study Population

The study included 96 patients undergoing orthopedic trauma surgery at the Department of Orthopedic Surgery, North East Medical College and Hospital (NEMCH), Sylhet.

Inclusion Criteria

Patients aged 18 years and older.
Patients undergoing orthopedic trauma surgeries such as long bone fractures, pelvic fractures, or periarticular fractures.
Patients who provided informed consent for participation in the study.

Exclusion Criteria

Patients with known hypersensitivity or contraindications to TXA.
History of thromboembolic disorders (e.g., deep vein thrombosis, pulmonary embolism, or cerebrovascular events).
Patients with coagulopathy or receiving anticoagulant therapy.
Pregnant or lactating women.

Study Procedure

Patients scheduled for orthopedic trauma surgeries were assessed preoperatively, and those meeting the inclusion criteria were enrolled in the study. TXA was administered intravenously at a dose of 15 mg/kg body weight approximately 30 minutes before surgical incision. Standardized anesthetic and surgical protocols were followed for all patients to ensure uniformity. Perioperative blood loss was measured intraoperatively by collecting and quantifying blood in surgical suction containers and by weighing surgical sponges. Postoperative blood loss was recorded from drain output within the first 24 hours after surgery. The need for allogeneic blood transfusion was determined based on clinical and laboratory parameters, including hemoglobin levels and

hemodynamic stability. The total number of blood units transfused during the perioperative period was documented.

Data Collection

Relevant demographic and clinical data were collected, including age, sex, type of surgery, duration of surgery, and baseline hemoglobin levels. Outcomes measured included total blood loss (intraoperative and postoperative) and the number of blood transfusions required. Adverse events, including thromboembolic complications, were monitored and recorded.

Statistical Analysis

Data were analyzed using statistical software. Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages. Comparative analysis was performed using the t-test or Mann-Whitney U test for continuous variables and the chi-square test for categorical variables. A p-value of <0.05 was considered statistically significant.

Ethical Considerations

Ethical approval for the study was obtained from the Institutional Review Board of North East Medical College and Hospital. Written informed consent was obtained from all participants prior to their inclusion in the study. The confidentiality of patient information was strictly maintained throughout the study.

Results

Table 1: Demographic Characteristics of the Study Population

Parameter	TXA Group (n=48)	Control Group (n=48)	Total (n=96)	p-value
Age (Years)				
Mean ± SD	42.6 ± 11.9	43.0 ± 12.7	42.8 ± 12.3	0.81
Range	18-68	19-70	18-70	
Type of Trauma				
Upper Limb Fractures (%)	35.4	37.5	36.5	0.77
Lower Limb Fractures (%)	64.6	62.5	63.5	0.77
Fracture Classification				
Closed Fractures (%)	78.8 (38)	83.3 (40)	81.1 (78)	0.56
Open Fractures (%)	21.2 (10)	16.7 (8)	18.9 (18)	0.56
Comorbidities				
Hypertension (%)	18.7 (9)	16.7 (8)	17.7 (17)	0.71
Diabetes Mellitus (%)	12.5 (6)	10.4 (5)	11.5 (11)	0.62
Smoking History (%)	25.0 (12)	22.9 (11)	23.9 (23)	0.72
Preoperative Hemoglobin (g/dL)				
Mean ± SD	13.2 ± 2.1	13.4 ± 1.9	13.3 ± 2.0	0.79
Range	10.0 - 15.0	10.5 - 15.5	10.0 - 15.5	
Preoperative Platelet Count (×10³/µL)				
Mean ± SD	220 ± 55	225 ± 60	222 ± 58	0.71
Range	140 - 300	150 - 310	140 - 310	

Table 1 presents the demographic characteristics of the study population, showing no significant differences between the TXA and control groups. The mean age was 42.6 ± 11.9 years in the TXA group and 43.0 ± 12.7 years in the control group ($p = 0.81$). Trauma types were similar, with 35.4% of the TXA group and 37.5% of the control group having upper limb fractures. Fracture classifications, comorbidities (hypertension, diabetes, and smoking), and preoperative hemoglobin (13.2 ± 2.1 g/dL vs. 13.4 ± 1.9 g/dL) and platelet counts (220 ± 55 × 10^3/µL vs. 225 ± 60 × 10^3/µL) showed no significant differences ($p > 0.05$ for all).

Table 2: Gender Distribution in TXA and Control Groups

Group	Male (%)	Female (%)	Total (%)
TXA Group (n=48)	60.4 (29)	39.6 (19)	100 (48)

Control Group (n=48)	56.3 (27)	43.7 (21)	100 (48)
Total (n=96)	58.3 (56)	41.7 (40)	100 (96)

Table 2 presents the gender distribution between the TXA and control groups. In the TXA group, 60.4% (29) were male and 39.6% (19) were female. In the control group, 56.3% (27) were male and 43.7% (21) were female. The overall population comprised 58.3% males (56) and 41.7% females (40), with no significant differences between the groups.

Table 3: Intraoperative Blood Loss

Parameter	TXA Group (n=48)	Control Group (n=48)	p-value
Mean Blood Loss (mL)	220 ± 45	340 ± 55	<0.01
Patients with Blood Loss >300 mL (%)	12.5 (6)	41.7 (20)	<0.01

Table 3 compares the intraoperative blood loss between the TXA and control groups. The mean blood loss in the TXA group was significantly lower at 220 ± 45 mL compared to 340 ± 55 mL in the control group ($p < 0.01$). Additionally, only 12.5% (6) of patients in the TXA group experienced blood loss exceeding 300 mL, while 41.7% (20) of the control group had blood loss greater than 300 mL, a significant difference ($p < 0.01$).

Table 4: Postoperative Blood Loss

Parameter	TXA Group (n=48)	Control Group (n=48)	p-value
Mean Blood Loss (mL)	150 ± 35	280 ± 50	<0.01
Patients with Blood Loss >250 mL (%)	10.4 (5)	37.5 (18)	<0.01

Table 4 presents postoperative blood loss data. The TXA group had a mean blood loss of 150 ± 35 mL, significantly lower than the 280 ± 50 mL in the control group ($p < 0.01$). Furthermore, 10.4% (5) of patients in the TXA group had postoperative blood loss exceeding 250 mL, compared to 37.5% (18) in the control group, highlighting a significant reduction in blood loss with TXA ($p < 0.01$).

Table 5: Blood Transfusion Requirements

Parameter	TXA Group (n=48)	Control Group (n=48)	p-value
Patients Requiring Transfusion (%)	18.7 (9)	37.5 (18)	0.02
Mean Units Transfused	0.6 ± 0.4	1.3 ± 0.5	<0.01

Table 5 shows blood transfusion requirements between the two groups. In the TXA group, 18.7% (9) of patients required a transfusion, while 37.5% (18) of the control group needed transfusions ($p = 0.02$). Additionally, the mean number of units transfused in the TXA group was 0.6 ± 0.4, significantly lower than the 1.3 ± 0.5 units in the control group ($p < 0.01$).

Table 6: Thromboembolic Events

Parameter	TXA Group (n=48)	Control Group (n=48)	p-value
Deep Vein Thrombosis (DVT) (%)	2.1 (1)	4.2 (2)	0.51
Pulmonary Embolism (%)	0.0 (0)	0.0 (0)	-

Table 6 compares thromboembolic events in both groups. Deep vein thrombosis (DVT) occurred in 2.1% (1) of the TXA group and 4.2% (2) of the control group, with no significant difference ($p = 0.51$). No patients in either group experienced pulmonary embolism (p-value not applicable).

Table 7: Surgical and Hospitalization Outcomes

Parameter	TXA Group (n=48)	Control Group (n=48)	p-value
Duration of Surgery (hours)	3.1 ± 0.4	3.3 ± 0.5	0.18
Hospital Stay (days)	5.2 ± 1.1	6.5 ± 1.4	<0.01

Table 7 provides data on surgical duration and hospitalization. The average duration of surgery in the TXA group was 3.1 ± 0.4 hours, slightly shorter than the 3.3 ± 0.5 hours in the control group, but this

difference was not statistically significant (p = 0.18). However, the TXA group had a significantly shorter hospital stay (5.2 ± 1.1 days) compared to the control group (6.5 ± 1.4 days) (p < 0.01).

Table 8: Overall Perioperative Outcomes

Parameter	TXA Group (n=48)	Control Group (n=48)	p-value
Total Blood Loss (mL)	370 ± 55	620 ± 80	<0.01
Reduction in Blood Loss (%)	40.3	-	<0.01

The overall perioperative outcomes. The total blood loss in the TXA group was 370 ± 55 mL, significantly lower than 620 ± 80 mL in the control group (p < 0.01). The TXA group also demonstrated a 40.3% reduction in total blood loss compared to the control group, with a significant p-value (p < 0.01).

Discussion

The present study aimed to assess the impact of tranexamic acid (TXA) on perioperative blood loss and transfusion requirements in orthopedic trauma surgery. The results revealed that TXA significantly reduced both intraoperative and postoperative blood loss, as well as the need for blood transfusions, compared to the control group. These findings align with numerous studies demonstrating the efficacy of TXA in minimizing blood loss during orthopedic procedures[11,12]. Intraoperative blood loss was markedly reduced in the TXA group (220 ± 45 mL) compared to the control group (340 ± 55 mL), a difference that was statistically significant (p < 0.01). This result is consistent with previous research, which has shown that TXA effectively reduces bleeding during surgeries, particularly in trauma and orthopedic cases[13,14]. Additionally, fewer patients in the TXA group experienced blood loss exceeding 300 mL, further supporting the benefits of TXA in controlling hemorrhage during surgery[15].

Postoperative blood loss also showed a significant reduction in the TXA group, with a mean blood loss of 150 ± 35 mL compared to 280 ± 50 mL in the control group (p < 0.01). The reduction in postoperative blood loss is critical, as it reduces the risk of complications such as wound infections and delayed recovery. Several studies have highlighted the role of TXA in minimizing postoperative bleeding and improving recovery times in orthopedic patients[16,17]. A key outcome of this study was the reduction in blood transfusion requirements. Only 18.7% of patients in the TXA group required a transfusion, compared to 37.5% in the control group (p = 0.02). Additionally, the mean number of units transfused in the TXA group was 0.6 ± 0.4, significantly lower than the 1.3 ± 0.5 units in the control group (p < 0.01). These results are in line with other studies that have reported a significant decrease in the need for blood transfusions following the administration of TXA during orthopedic surgeries[18]. The reduction in transfusion rates is particularly important, as transfusions carry risks of infection, transfusion reactions, and increased healthcare costs[19].

Regarding thromboembolic events, no significant differences were observed between the TXA and control groups. Deep vein thrombosis (DVT) was reported in 2.1% of the TXA group and 4.2% in the control group, but the difference was not statistically significant (p = 0.51). Previous studies have raised concerns about the potential thromboembolic risk associated with TXA, but most research suggests that the risk remains low when used in the appropriate clinical context[20,21]. No cases of pulmonary embolism were reported in either group, which further supports the safety profile of TXA in orthopedic trauma surgery. Surgical outcomes, including the duration of surgery and hospitalization, did not differ significantly between the two groups. The TXA group had a slightly shorter hospital stay (5.2 ± 1.1 days) compared to the control group (6.5 ± 1.4 days), a difference that may be attributed to reduced blood loss and faster recovery. These findings are consistent with studies that suggest TXA contributes to improved recovery and earlier discharge from the hospital[22]. In conclusion, the results of this study provide strong evidence supporting the use of TXA in orthopedic trauma surgery to reduce perioperative blood loss, minimize the need for transfusions, and improve patient outcomes. While the risk of thromboembolic events remains a concern, the benefits of TXA in reducing bleeding and enhancing recovery outweigh the potential risks, making it a valuable adjunct in orthopedic trauma

management. Further large-scale, multicenter trials are needed to confirm these findings and better define the safety profile of TXA in this context.

This study has some limitations, including its single-center design, which may limit generalizability, and a relatively small sample size, reducing statistical power. The short follow-up period focused on perioperative outcomes, without assessing long-term recovery or complications. Additionally, the lack of blinding and randomization introduces potential bias, and unmeasured confounding factors, such as variations in surgeon experience, may have influenced the results.

Conclusion

Tranexamic acid (TXA) significantly reduced perioperative blood loss and the need for blood transfusions in orthopedic trauma surgery, demonstrating its effectiveness in improving patient outcomes. TXA was safe, with no notable increase in thromboembolic events. These findings highlight the potential of TXA as a routine adjunct in orthopedic trauma surgeries to enhance recovery and minimize complications.

Tranexamic Acid (TXA) should be integrated into routine perioperative protocols for orthopedic trauma surgeries, especially in resource-limited settings, to reduce blood loss, transfusion needs, and associated costs. Multicenter studies with larger sample sizes and long-term follow-ups are recommended to confirm the safety and efficacy of TXA, particularly regarding delayed thromboembolic events. Healthcare professionals should receive training on the optimal use of TXA to maximize its benefits while minimizing potential complications. Additionally, continuous monitoring of TXA's safety profile and cost-effectiveness should be encouraged to ensure its appropriate use in various clinical contexts.

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