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Research Article

Efficacy of Prophylactic Tranexamic Acid in Preventing Postpartum Hemorrhage among Preeclamptic Patients Undergoing Cesarean Section

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ABSTRACT

Morbidity and mortality worldwide, accounting for nearly one-fourth of maternal deaths, particularly in low- and middle-income countries.

Objective: To evaluate the efficacy of prophylactic tranexamic acid in preventing postpartum hemorrhage among preeclamptic patients undergoing cesarean section.

Methodology: This interventional study was conducted at the department of Gynaecology and Obstetrics, Shalamar Hospital, Lahore, Pakistan from May 2024 to June 2025. A total of 105 preeclamptic women scheduled for elective or emergency cesarean section were enrolled and randomly divided into two groups. Group A (TXA group, n = 53) received 1 gram of tranexamic acid intravenously 10 minutes before skin incision, while Group B (control group, n = 52) received 20 mL of normal saline as placebo. Intraoperative and postoperative blood loss were measured using suction volume and mop weight.

Results: The mean intraoperative blood loss was significantly lower in the TXA group (550 ± 120 mL) compared to the control group (720 ± 140 mL, p = 0.001). Postoperative blood loss within the first two hours was also reduced in the TXA group (90 ± 25 mL vs. 130 ± 30 mL, p = 0.002). The decline in hemoglobin (0.7 ± 0.3 g/dL vs. 1.5 ± 0.4 g/dL, p = 0.001) and hematocrit (2.4 ± 1.1% vs. 4.3 ± 1.3%, p = 0.001) was significantly smaller in the TXA group. The need for additional uterotonics (9.4% vs. 26.9%, p = 0.02) and blood transfusion (5.6% vs. 19.2%, p = 0.03) was lower in the TXA group. No thromboembolic complications or serious adverse reactions were reported in either group.

Conclusion: Prophylactic administration of tranexamic acid before cesarean section in preeclamptic patients significantly reduces intraoperative and postoperative blood loss, minimizes hemoglobin and hematocrit decline, and lowers the need for additional uterotonics and blood transfusions without increasing adverse events.

Keywords: Preeclampsia, Tranexamic acid, Cesarean section, Postpartum hemorrhage, Blood loss, Prevention

INTRODUCTION

Postpartum hemorrhage (PPH) remains one of the most critical challenges in modern obstetric care and continues to be a major cause of maternal mortality and morbidity worldwide [1]. The World Health Organization (WHO) considers a 500ml or more of blood loss after vaginal delivery or over 1000ml after cesarean section in the first 24 hours of the birth as PPH [2]. It is estimated that 14 million women across the globe contract PPH each year, and 70,000 women die due to the condition, the majority of them in low and middle-income nations where blood transfusion services, as well as emergency obstetric care, are scarce [3]. Regardless of improvement in the obstetric methods and other preventive strategies, PPH has continued to pose a serious risk, especially in those women who have predisposing factors like preeclampsia, multiple gestation, or who are in prolonged labor [4]. Preeclampsia is a multisystem symptomatic disorder that is defined by hypertension and proteinuria following a gestation period of 20 weeks and is linked with abnormal placentation, endothelial dysfunction, and coagulopathy [5]. Such pathophysiological alterations not only increase the tendency to bleeding, but also deteriorate the contractility of the uterus and the hemostasis during and after childbirth. Preeclampsia combined with cesarean delivery predisposes one to the risks of PPH significantly because the medical aspect of the operation exposes one to further hemodynamic and tissue effects [6]. It has been demonstrated that the risk of severe postpartum blood loss remains nearly twofold higher among women with preeclampsia who deliver via cesarean section than those who deliver normotensive [7]. As such, it is important to determine effective and safe prophylaxis measures in this population at risk to mitigate the maternal complications. Tranexamic acid (TXA) is a synthetic lysine analog that prevents the dissociation of plasminogen to plasmin, the fibrin-degrading enzyme [8].

TXA prevents the fibrinolysis process, stabilizing blood clots and decreasing blood loss. The medication has been well investigated in most surgical fields, such as cardiac, orthopedic, and trauma surgery, where it has been shown to be effective in reducing the amount of perioperative bleeding and transfusion needed. Based on these results, there has been more interest in using TXA prophylactically, particularly in females who have cesarean sections [9]. Some randomized controlled trials and meta-analyses have indicated that preoperative TXA administered before skin incision or postnatal delivery of the infant may greatly help in curbing the intraoperative blood loss and postnatal bleeding [10]. Nevertheless, this has caused inconsistent conclusions because of the differences in the study populations, dose projects, and their time of delivery. In addition, the vast majority of available data are on non-high-risk populations of the general obstetrics and not on high-risk cohorts like preeclamptic women, whose response may be different because of their altered coagulation profile and vascular reactivity [11].

Both hypercoagulability and consumptive coagulopathy can be caused by physiological alterations in preeclampsia, platelet activation, elevated thromboxane release, and a reduction in prostacyclin release [12]. This two-fold risk makes management choices on antifibrinolytic treatment more complex because too much inhibition of fibrinolysis may hypothetically put patients at risk of thrombosis, and too little inhibition leads to the risk of severe hemorrhage, shock, and transfusion [13]. Therefore, there is a great need to assess the efficacy and safety of TXA in this group of patients. This question has been investigated in studies conducted in various regions in recent years [14]. Others have shown that prophylactic TXA is effective in the reduction of blood loss and required supplemental uterotonic agents in preeclamptic patients during cesarean section, and some show insignificant

effects in hypertensive patients with vasospasm-induced uterine hypoperfusion. The absence of a consensus highlights the necessity to conduct additional research in controlled settings and consider local demographics of patients, the severity of the disease, and perioperative procedures [15].

Objective

To evaluate the efficacy of prophylactic tranexamic acid in preventing postpartum hemorrhage among preeclamptic patients undergoing cesarean section.

METHODOLOGY

This was an interventional study conducted at department of Gynaecology and Obstetrics, Shalamar Hospital, Lahore, Pakistan from May 2024 to June 2025. A total of 105 preeclamptic women were enrolled using non-probability consecutive sampling and divided into two groups: Group A (TXA group, n = 53) and Group B (control group, n = 52).

Inclusion Criteria

- Diagnosed preeclampsia at ≥37 weeks of gestation
- Singleton pregnancy scheduled for elective or emergency cesarean section
- Provided informed written consent

Exclusion Criteria

- History of thromboembolic disease or coagulopathy
- Placenta previa, placental abruption, or uterine rupture
- Liver or renal dysfunction
- Known hypersensitivity to tranexamic acid
- Use of anticoagulant or antiplatelet medication

Data Collection

Demographic and clinical data were recorded using a structured proforma. There was a comparison of blood loss and laboratory parameters. Group A patients were given tranexamic acid (1 gram) intravenously in 20 mL of normal saline and diluted over five minutes, and then administered over ten minutes slowly over the next five minutes prior to skin incision. An equal amount of normal saline was administered to group B as a placebo in the same procedure. Every cesarean section was done with spinal anesthesia and by skillful obstetricians. Following the baby delivery, 10 IU oxytocin was administered intravenously, and 20 IU was infused in 1 L of normal saline. Aseptic practices and intraoperative observation were observed during the operation. The estimated blood loss (EBL) during the intraoperative and postoperative period was the primary outcome and was measured by way of suction volume and surgical mops weight. Secondary outcomes were the alterations of hemoglobin and hematocrit 24 hours after the operation, the necessity of extra uterotonic drugs, blood transfusion, and such adverse events as nausea, vomiting, thromboembolism.

Data Analysis

Data were analyzed using SPSS version 26. Quantitative variables such as age, EBL, hemoglobin, and hematocrit were presented as mean ± standard deviation and compared using the independent t-test. Qualitative variables such as transfusion requirement and complications were analyzed using the chi-square test. A p-value less than 0.05 was considered statistically significant.

RESULTS

Data were collected from 105 patients, mean age of patients was 29.4 ± 4.8 years in the TXA group and 30.1 ± 5.1 years in the control group. The average gestational age at delivery was nearly identical in both groups (37.6 ± 1.2 weeks vs. 37.4 ± 1.3 weeks). Parity was also similar, with a mean of 2.1 ± 1.1 in the TXA group and 2.0 ± 1.2 in the control group. Elective cesarean sections comprised 60.4% of cases in the TXA group and 57.7% in the control group, while mean preoperative hemoglobin levels were comparable (11.3 ± 0.9 g/dL vs. 11.4 ± 1.0 g/dL) (Table 1).

Table 1. Baseline Demographic and Clinical Characteristics of Patients (n = 105)

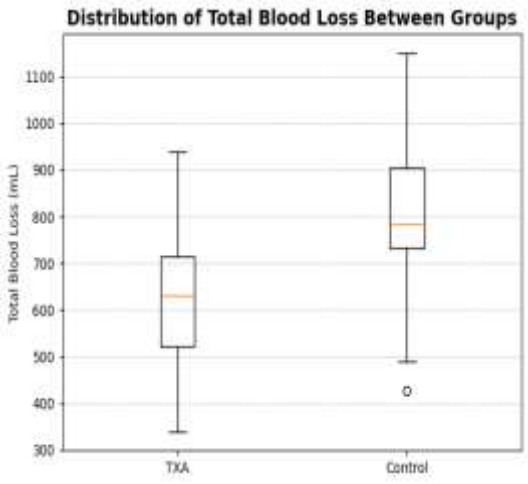
Variable	TXA Group (n = 53)	Control Group (n = 52)
Mean age (years)	29.4 ± 4.8	30.1 ± 5.1
Mean gestational age (weeks)	37.6 ± 1.2	37.4 ± 1.3
Parity (mean)	2.1 ± 1.1	2.0 ± 1.2
Type of cesarean (Elective %)	32 (60.4%)	30 (57.7%)
Mean preoperative Hb (g/dL)	11.3 ± 0.9	11.4 ± 1.0

Intraoperative and Postoperative Blood Loss and Hematologic Changes

The mean estimated intraoperative blood loss in the TXA group was 550 ± 120 mL, significantly lower than 720 ± 140 mL in the control group (p = 0.001). Similarly, postoperative blood loss during the first two hours was reduced in the TXA group (90 ± 25 mL vs. 130 ± 30 mL, p = 0.002), and total blood loss was markedly lower (640 ± 130 mL vs. 850 ± 150 mL, p = 0.001). The hematologic parameters reflected the same trend: the mean postoperative hemoglobin was higher in the TXA group (10.6 ± 0.8 g/dL) than in controls (9.9 ± 0.9 g/dL, p = 0.004), while the decline in hemoglobin was significantly smaller (0.7 ± 0.3 g/dL vs. 1.5 ± 0.4 g/dL, p = 0.001). Postoperative hematocrit also remained higher in the TXA group (31.8 ± 2.6%) compared to the control group (29.2 ± 2.9%, p = 0.003).

Table 2. Intraoperative and Postoperative Blood Loss and Hematologic Changes

Parameter	TXA Group (n = 53)	Control Group (n = 52)	p-value
Estimated intraoperative blood loss (mL)	550 ± 120	720 ± 140	0.001
Postoperative blood loss (mL, first 2 hours)	90 ± 25	130 ± 30	0.002
Total blood loss (mL)	640 ± 130	850 ± 150	0.001
Postoperative Hb (g/dL)	10.6 ± 0.8	9.9 ± 0.9	0.004
Fall in Hb (g/dL)	0.7 ± 0.3	1.5 ± 0.4	0.001
Postoperative Hct (%)	31.8 ± 2.6	29.2 ± 2.9	0.003
Fall in Hct (%)	2.4 ± 1.1	4.3 ± 1.3	0.001

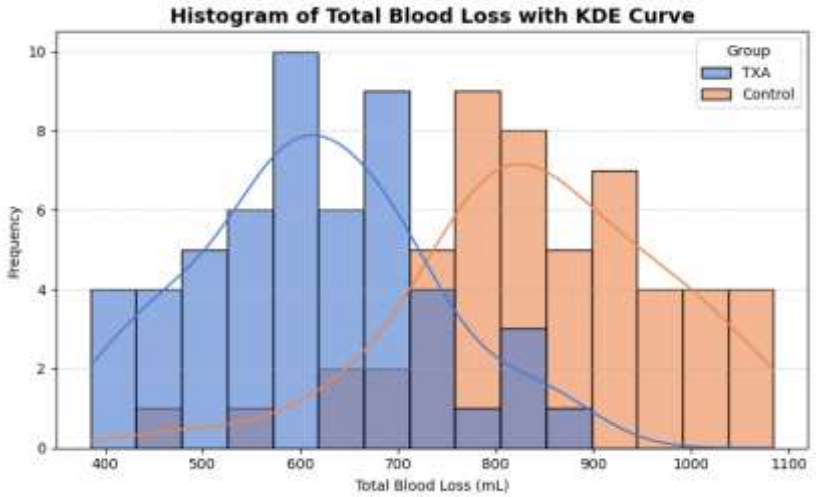


Uterotonics, Blood Transfusion, and Adverse Events

The need for additional uterotonics was considerably lower in the TXA group (9.4%) compared to the control group (26.9%), with a p-value of 0.02. Similarly, blood transfusion was required in only 3 patients (5.6%) in the TXA group versus 10 patients (19.2%) in the control group (p = 0.03). Adverse effects were mild and infrequent; nausea and vomiting occurred in 7.5% of TXA patients and 5.8% of controls, which was not statistically significant (p = 0.72).

Table 3. Requirement of Additional Uterotonics, Blood Transfusion, and Adverse Events

Outcome	TXA Group (n = 53)	Control Group (n = 52)	p-value
Additional uterotonics required	5 (9.4%)	14 (26.9%)	0.02
Blood transfusion required	3 (5.6%)	10 (19.2%)	0.03
Nausea/Vomiting	4 (7.5%)	3 (5.8%)	0.72
Thromboembolic events	0 (0%)	0 (0%)	—



Postpartum Hemodynamic Parameters

The mean postoperative systolic blood pressure was slightly higher in the TXA group (126 ± 9 mmHg) compared to controls (122 ± 10 mmHg), though this difference was not statistically significant (p = 0.07). Similarly, mean diastolic pressure was comparable (82 ± 6 mmHg vs. 80 ± 7 mmHg, p = 0.18). However, the mean postoperative pulse rate was significantly lower in the TXA group (82 ± 8 beats/min) compared to controls (88 ± 9 beats/min, p = 0.01), suggesting improved hemodynamic stability due to reduced blood loss. Additionally, the mean hospital stay was shorter among TXA recipients (3.8 ± 0.9 days) than controls (4.5 ± 1.1 days, p = 0.02).

Table 4. Postpartum Hemodynamic Parameters

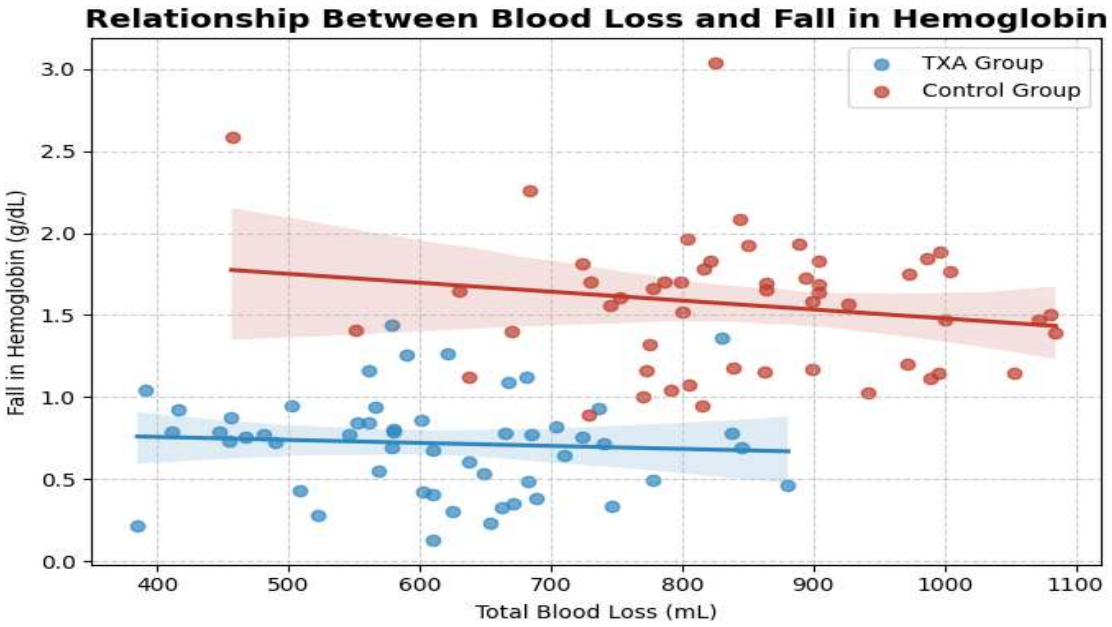
Parameter	TXA Group (n = 53)	Control Group (n = 52)	p-value
Mean systolic BP (mmHg) post-op	126 ± 9	122 ± 10	0.07
Mean diastolic BP (mmHg) post-op	82 ± 6	80 ± 7	0.18
Mean pulse rate (beats/min)	82 ± 8	88 ± 9	0.01
Duration of hospital stay (days)	3.8 ± 0.9	4.5 ± 1.1	0.02

Postpartum Hemorrhage (PPH) Severity

In the TXA group, 96.2% of patients experienced no PPH, compared to 76.9% in the control group (p = 0.005). Mild PPH (1000–1500 mL) occurred in only 2 patients (3.8%) in the TXA group versus 9 patients (17.3%) in the control group (p = 0.03).

Table 5. Distribution of Postpartum Hemorrhage (PPH) Severity

Severity of PPH	TXA Group (n = 53)	Control Group (n = 52)	p-value
No PPH (<1000 mL)	51 (96.2%)	40 (76.9%)	0.005
Mild PPH (1000–1500 mL)	2 (3.8%)	9 (17.3%)	0.03
Severe PPH (>1500 mL)	0 (0%)	3 (5.8%)	0.04



DISCUSSION

This study evaluated the efficacy of prophylactic tranexamic acid (TXA) in preventing postpartum hemorrhage (PPH) among preeclamptic patients undergoing cesarean section. These findings showed that 1 gram of TXA intravenously prior to skin incision showed a significant reduction in the intraoperative and postoperative blood loss, reduced the decrease in the hemoglobin and hematocrit levels, and decreased the need to use more uterotonic agents and blood transfusion than the control group. No significant adverse event or thromboembolism occurred and confirming the safety and effectiveness of TXA in this high-risk obstetric group. The results are in line with the past studies on the subject, where prophylactic TXA was effective in the reduction of intraoperative blood loss during cesarean section. Previous studies have demonstrated that TXA, when used preoperative, stabilizes fibrin clots and inhibits over fibrinolysis the resulting in decreased postpartum bleeding [17]. The same outcomes were communicated by the studies that were carried out in normotensive pregnant women, during which the application of TXA greatly reduced the blood loss without any changes in the coagulation parameters. The current research extrapolates these results to preeclamptic women who are naturally susceptible to bleeding because of endothelial pathology

and abnormal platelet functions, demonstrating that TXA has similar hemostatic advantages even in the complicated physiological circumstances. In the present research, the average estimated intraoperative blood loss among the TXA group (550 +- 120 mL) was significantly lower than in the control group (720 +- 140 mL) [18]. Also, the decrease in the level of hemoglobin and hematocrit was considerably slighter in the TXA group, which proves the effectiveness of the latter in ensuring perioperative hemodynamic stability. Such findings are in line with past randomized controlled studies, which also provided findings that TXA preoperative administration before cesarean section decreased total blood loss by 20-30 percent and reduced the probability of PPH. The decreased need for supplementary uterotonic medications and blood transfusions also defends the importance of TXA in clinical practice [19]. The preeclampsia patients usually manifest and exhibit the impairment of uterine contractility caused by the vascular spasm and ischemia, that increases their susceptibility to atonic bleeding. This study has an important finding because thromboembolic events were absent despite preeclampsia itself having hypercoagulability. Despite the theoretical risk relating to the prothrombotic nature of antifibrinolytic agents, the majority of recent studies, such as the WOMAN trial and subsequent meta-analyses, have found that there is no statistically significant risk of increasing venous thromboembolism in obstetric patients using TXA [20]. This safety profile is supported by the current study, and it may be assumed that prophylactic TXA is safe when carefully used [21]. The other interesting finding was that the hospital stay was shorter in the group of patients in the TXA. The decreased bleeding must have helped them to recover quickly, require fewer transfusions, and experience fewer complications in the post-operative period [22]. The implication of this finding on resource-constrained healthcare environments is significant because when the need to stay in a hospital and transfusion demand can be reduced, the cost of healthcare in the hospitals can be significantly lowered, and hence the demands on blood banks tend to be lower [23].

The current research reinforces the findings that prophylactic use of TXA in cesarean section is beneficial, especially in high-risk categories, which include preeclamptic women. Its ease of administration, cost-effectiveness, and good safety profile are the reasons why it can be a beneficial supplement to the current PPH prevention protocols [24,25]. Furthermore, TXA is room-temperature stable and is very common and hence a viable solution even in rural or low-resource hospitals where the occurrence of maternal mortality due to hemorrhage is still high. There are certain restrictions to be considered, though. It was a moderate-sized, single-center study that might not be generalizable. There was a brief follow-up, and a prolonged thromboembolic follow-up was not done. Also, the methods of estimating blood loss are standardized, but there might be inherent variability in them. Despite these, the results can be widely used as preliminary evidence to justify the use of TXA as a routine prophylaxis among preeclamptic patients during the performance of cesarean delivery.

CONCLUSION

This study demonstrated that prophylactic administration of tranexamic acid effectively reduces intraoperative and postoperative blood loss in preeclamptic patients undergoing cesarean section. Patients who received TXA experienced significantly less decline in hemoglobin and hematocrit levels, along with reduced requirements for additional uterotonic agents and blood transfusions compared to the control group. Importantly, no thromboembolic complications or major adverse effects were observed, confirming

the safety of TXA in this high-risk obstetric population.

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