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# Topical Tranexamic Acid: Does it Limit the Blood Loss in Coronary Artery Bypass Graft Surgery Patients?

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## ABSTRACT

***Objective*:** To evaluate the effect of topical Tranexamic Acid (TXA) on postoperative bleeding in on-pump Coronary Artery Bypass Graft (CABG) surgery patients.

***Study Design*:** Quasi-experimental study.

***Place and Duration of Study*:** Department of Cardiac Surgery, Armed Forces Institute of Cardiology/National Institute of Heart Diseases, Rawalpindi Pakistan, from Mar to Nov 2025.

***Methodology*:** Using consecutive sampling, ninety patients, both genders, aged between 40-70 years, who were scheduled for elective on-pump CABG, were enrolled. Patients who had redo or emergency CABG, valvular or combined procedures, and those with bleeding disorders, chronic liver or kidney disease, an ejection fraction <40%, recent anticoagulation or antiplatelet therapy, or suffered intraoperative complications were excluded. Patients were assigned into two groups: the TXA-Group (n=45) received 2 g TXA/100 mL saline for pericardial and mediastinal washing, while the Control-Group (n=45) received only 100 mL saline. The groups were analyzed for postop blood loss and blood transfusions at 6, 12, and 24 hours.

***Results*:** The mean age of the participants was 58.67±9.04 years, with males comprising 71.1% of the study population. Postoperative blood loss was significantly reduced in the tranexamic acid (TXA) group compared with the control group across all evaluated time points. At 6 hours postoperatively, median blood loss was 60.00 mL (IQR: 40.00–120.00) in the TXA group versus 180.00 mL (IQR: 70.00–280.00) in the control group ($p$=0.001). Similar reductions were observed at 12 hours [120.00 mL (IQR: 50.00–150.00) vs. 180.00 mL (IQR: 100.00–250.00); $p$=0.001] and at 24 hours [150.00 mL (IQR: 70.00–200.00) vs. 200.00 mL (IQR: 130.00–280.00); $p$=0.01].

***Conclusion*:** Patients who did not receive topical TXA before chest closure had a significantly higher postoperative bleeding. Moreover, it is an effective and economical way for controlling non-surgical bleeding in CABG patients.

**Keywords**: Blood Loss, Blood Transfusions, Coronary Artery Bypass**,** Perioperative Care, Tranexamic Acid.

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## INTRODUCTION

Cardiovascular diseases can be managed through multiple strategies, including surgical intervention, which has been shown to reduce morbidity and mortality. Significant advances in cardiac surgery have contributed to a decline in postoperative complications.[1] Among these, postoperative bleeding remains a major cause of morbidity and mortality in Coronary artery bypass graft (CABG) surgery patients. To minimize bleeding, clot-stabilizing agents such as tranexamic acid (TXA) are routinely used during cardiac surgery.[2] However, systemic administration of TXA may increase the risk of thromboembolic events. In contrast, the local application of TXA results in lower systemic absorption, reducing the likelihood of adverse effects while providing comparable hemostatic benefits.[2,3]

Bleeding after cardiac surgery is commonly assessed by chest tube drainage and the need for transfusion of blood components. The Society of Thoracic Surgeons (2011) recommends intravenous TXA to reduce surgical bleeding (Class I recommendation). However, systemic TXA may increase the risk of thromboembolic events and postoperative seizures, particularly at higher doses.[4,5] Topical (intra-pericardial) application, in contrast, acts locally and minimizes systemic exposure and related risks.[6] Several studies have shown that topical TXA in on-pump CABG significantly reduces postoperative blood loss using various doses.[2,3] Meta-analysis findings further support its role in decreasing bleeding in cardiac surgery.[7] Shah *et al.*, similarly demonstrated a significant reduction in postoperative bleeding at 24 hours, confirming its hemostatic benefit.[8]

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Despite substantial international evidence demonstrating the effectiveness of topical TXA in reducing postoperative bleeding, its routine use remains limited in AFIC setting. Current institutional practices primarily rely on conventional systemic strategies, and there is a noticeable lack of local data evaluating the safety and efficacy of topical TXA specifically in on pump CABG patients. This gap in context-specific evidence restricts informed decision-making and hinders the adoption of potentially safer, cost effective and targeted hemostatic methods. Therefore, this study aimed to evaluate the effect of locally applied TXA on postoperative bleeding and the need for blood transfusion products in on-pump CABG patients, generating local evidence that could guide clinical practice and support the use of topical TXA for improved hemostasis and reduced complications.

## METHODOLOGY

This study employed a Quasi-experimental design and was conducted over a period of nine months (Mar – Nov 2025) at Armed Forces Institute of Cardiology/National Institute of Heart Diseases, Rawalpindi. The study was approved by the Institutional Ethical Review Board (Ltr#9/2/R&D/2025/ 339; Dated: 5th March, 2025). Patients were enrolled through non probability consecutive sampling technique.

The sample size (n=40; 20 per study group) was determined using the OpenEpi sample size calculator. The calculation was based on postoperative bleeding volumes in the TXA-group and Control-group (654±224 mL vs. 891±295 mL, respectively)[9] at 95% confidence level, 80% power, and a 5% margin. However, this study enrolled 90 patients as 45 in TXA-Group and 45 in Control-Group.

**Inclusion Criteria:** Patients scheduled for elective surgery, specifically on-pump CABG, aged between 40 and 70 years, and of either gender were included in this study.

**Exclusion Criteria**: Patients with redo or emergency CABG, valvular or combined procedures bleeding disorders, chronic liver disease, or kidney failure (creatinine >1.7 mg/dL), active infective endocarditis, allergic to TXA, heparin prescribed within 48 hours prior to surgery, Ejection fraction (EF) below 40%, cases shifted to on-pump during surgery, anticoagulation or antiplatelet therapy within 5 hours before surgery, and cardiopulmonary bypass time exceeding 3 hours were excluded from the study.

All patients scheduled for on-pump CABG were evaluated with a complete history, general and cardiac examination, 12-lead ECG, chest X-ray, transthoracic echocardiography (TTE), coronary angiography, and relevant laboratory investigations. Demographic variables, including age, gender, weight, and comorbidities (hypertension, diabetes, smoking status), were recorded. Preoperative parameters such as type of coronary artery disease (SVCAD, DVCAD, TVCAD), number of conduits, hemoglobin, platelet count, coagulation profile (PTT, APTT, INR), and procedure time were documented. Patients meeting the inclusion criteria were enrolled after obtaining written informed consent. Standard anesthesia protocols were followed for all procedures. Patient flow is shown in Figure-1.

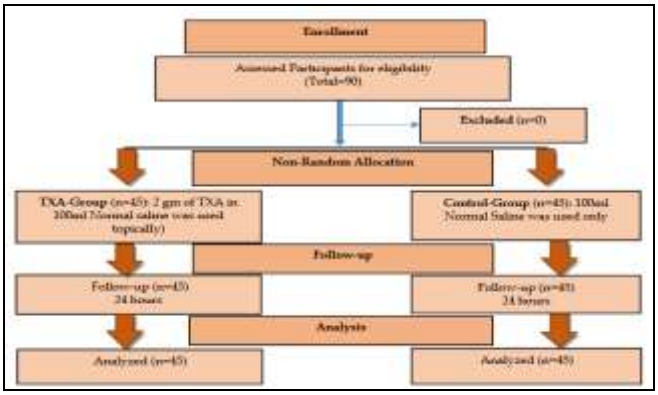


**Figure-1: Patient Flow Diagram**

Eligible patients were non-randomly assigned into two groups. In TXA-Group, the pericardial and mediastinal cavities were washed with 100 mL of normal saline containing 2g of tranexamic acid at the end of the procedure, before sternal closure with steel wires. In Control-Group, the cavity was washed with 100mL of normal saline only. Intraoperative parameters recorded included number of grafts, procedure time, cardiopulmonary bypass time, aortic cross-clamp time, and transfusion of blood products including RBCs, fresh frozen plasma (FFP), platelets, and cryoprecipitate. Sternum closure was performed similarly in both groups, and heparin was reversed according to the activated clotting time (ACT). Chest drains were unclamped following skin closure, and the cavity wash procedure required approximately 15–20 minutes.

Postoperatively, patients were monitored in the ICU and wards according to clinical condition. Postoperative parameters included hemoglobin, hematocrit, and coagulation profile and chest tube drainage at 6, 12, and 24 hours. Blood transfusion was administered according to standard protocols during surgery: RBCs were transfused if Hb <7 g/dL, platelets if <50,000/µL, FFP if APTT >1.5, and cryoprecipitate if fibrinogen <100 mg/dL.

All statistical analyses were performed using Statistical Package of Social Package (SPSS) version 23.0. All continuous variables were first tested for normality using the Shapiro Wilk test. Hemoglobin, platelet count, PT, APTT, INR, procedure time, CPB time, and aortic clamp time were normally distributed, while postoperative blood loss was not normally distributed. Normally distributed continuous variables were reported as Mean±SD and compared using independent-sample t-tests; categorical variables were compared using Chi-square. Non-normally distributed variables, including postoperative blood loss, were summarized as median (IQR), compared between groups using the Mann–Whitney U test, and within-group changes over time were assessed by the Friedman test. A *p*-value ≤0.05 was considered statistically significant.

## RESULTS

A total of 90 patients were included in the study, with an overall mean age of 58.67±9.04 years. The mean age in TXA-Group was slightly higher (59.16±10.11 versus 58.18±7.94 years). Males (71.1%) were dominant in overall cohort. All differences were statistically non-significant, indicating that both groups were comparable at baseline ($p$>0.05) as shown in Table-I.

The distribution of coronary artery disease types differed significantly between both groups ($p$<0.05) [Figure-2]. In TXA-Group, the majority of patients had triple vessel disease (TVCAD) accounting for 84.1%, followed by double vessel disease (DVCAD) at 9.1%, and single vessel disease (SVCAD) at 6.8%.

There were no significant differences observed between both groups in intraoperative parameters. Procedure time CPB time aortic clamp time number of grafts, as well as postoperative labs and blood transfusions, were comparable between groups ($p$>0.05) (Table–II).

Postoperative blood loss was significantly lower in the TXA group at all-time points compared to control group: 6 hours [60 (40–120) vs. 180 (70–280) mL; $p$=0.001], 12 hours [120.00 (50.00–150.00) vs. 180.00 (100.00–250.00) mL; $p$=0.001], and 24 hours [150.00 (70.00–200.00) vs. 200.00 (130.00–280.00) mL; $p$=0.01]. Within-group comparisons over time showed slight increases in blood loss in both groups. Overall, the topical application of TXA effectively reduced postoperative bleeding versus control throughout the first 24 hours after surgery (Table- III).

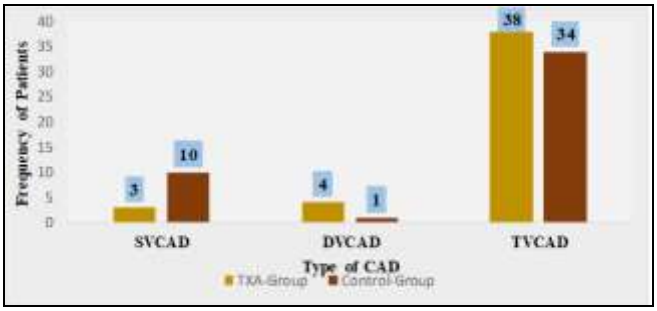


**Figure-2: Distribution of Type of CAD across study groups (n=90)**

**Table-I: Baseline Characteristics of study Participants (n=90)**

| Variables | | Total (n=90) | TXA- Group (n=45) | Control Group (n=45) | *p*-value |
|---|---|---|---|---|---|
| | | | [Mean± SD] | | |
| **Demographics** | | | | | |
| Age(years) | | 58.67±9.04 | 59.16±10.11 | 58.18±7.94 | 0.61 |
| BMI(m2) | | 27.00±4.37 | 26.34±4.16 | 27.63±4.49 | 0.10 |
| | | | Frequency (%) | | |
| Gender | Female | 26(28.9%) | 13(28.9%) | 13(28.9%) | 1.00 |
| | Male | 64(71.1%) | 32(71.1%) | 32(71.1%) | |
| **Comorbid** | | | Frequency (%) | | |
| DM | No | 44(48.9%) | 22(48.9%) | 22(48.9%) | 1.00 |
| | Yes | 46(51.1%) | 23(51.5%) | 23(51.5%) | |
| HTN | No | 33(36.7%) | 18(40.0%) | 15(33.3%) | 0.66 |
| | Yes | 57(63.3%) | 27(60.0%) | 30(66.7%) | |
| Smoking Status | Ex-Smoker | 2(2.2%) | 1(2.2%) | 1(2.2%) | 0.82 |
| | Non-Smoker | 61(67.8%) | 32(71.1%) | 29(64.4%) | |
| | Current | 27(30.0%) | 12(26.7%) | 15(33.3%) | |
| **Preoperative Parameters** | | | [Mean± SD] | | |
| Lab Findings | Platelet (µL) | 255.36±73.93 | 248.34±72.48 | 262.75±75.52 | 0.42 |
| | Hb (g/dL) | 11.72±0.85 | 11.65±0.87 | 11.79±0.81 | 0.62 |
| | PT | 11.48±1.29 | 11.42±1.25 | 11.54±1.33 | 0.44 |
| | APTT | 33.44±2.98 | 32.93±2.82 | 34.00±3.06 | 0.07 |
| | INR | 0.95±0.13 | 0.95±0.13 | 0.96±0.14 | 0.42 |

***DM**=Diabetes Mellitus; **HTN**=Hypertension; **Hb**=Hemoglobin; PT= Prothrombin Time; **APTT**= Activated Partial Thromboplastin Time; **INR**= International Normalized Ratio;TXA=Tranexamic acid*

## DISCUSSION

This study showed that the use of topical TXA during on-pump CABG surgery reduces blood loss after surgery. TXA patients had less output on their chest drain compared to the control group, indicating that hemostatic conditions were better.

Most importantly, the noted less bleeding did not result in greater risks or events, along with the described safety of TXA. Furthermore, the potential thromboembolic complications of the intravenous TXA antifibrinolytic agents have been studied for some time, as have the lower post-operative bleed claims with topical TXA.[10,11]

**Table-II: Comparison of intraoperative and postoperative parameters between study groups (n=90)**

| Variables | | TXA- Group (n=45) | Control-Group (n=45) | *p*-value |
|---|---|---|---|---|
| **Intraoperative Parameters** | | **[Mean±SD]** | | |
| Procedure Time (min) | | 308.75±46.41 | 295.29±34.20 | 0.11 |
| CPB Time (min) | | 124.31±34.50 | 120.02±32.04 | 0.65 |
| Aortic Clamp Time (min) | | 73.08±24.06 | 72.20±20.43 | 0.69 |
| | | **Frequency (%)** | | |
| **Grafts** | 1 | 5(11.1%) | 5(11.1%) | 0.38 |
| | 2 | 14(31.1%) | 19(42.2%) | |
| | 3 | 15(33.3%) | 16(35.6%) | |
| | 4 | 11(24.4%) | 5(11.1%) | |
| **Post-operative Parameters** | | **[Mean±SD]** | | |
| | Hb (g/dL) | 10.20±1.17 | 10.01±1.277 | 0.79 |
| | PT | 12.28±2.98 | 12.41±2.68 | 0.09 |
| | APTT | 32.78±3.65 | 33.96±3.59 | 0.34 |
| | INR | 1.10±0.22 | 1.14±0.25 | 0.65 |
| **Transfusions** | | **Frequency (%)** | | |
| **FFP** | No | 43(95.6%) | 43(95.6%) | 1.00 |
| | Yes | 2(4.4%) | 2(4.4%) | |
| **Cryoprecipitate** | No | 43(95.6%) | 43(95.6%) | 1.00 |
| | Yes | 2(4.4%) | 2(4.4%) | |
| **RBC units** | No | 3066.7%) | 33(73.3%) | 0.49 |
| | Yes | 12(26.7%) | 15(33.3%) | |

*TXA=Tranexamic acid* ***;Hb=****Hemoglobin; PT= Prothrombin Time;* ***APTT=*** *Activated Partial Thromboplastin Time;* ***INR=*** *International Normalized Ratio; CBP=Cardiopulmonary Bypass; FFP=Fresh Frozen Plasma; RBC=Red Blood Units*

**Table III: Postoperative Blood Loss Between and Within Study Groups at Different Points (n=90)**

| Outcome | Time points | TXA-Group (n=45) | | Control-Group (n=45) | *p*-value |
|---|---|---|---|---|---|
| | | **Median(IQR)** | | | |
| | | **(Between group)** | | | |
| **Blood loss(ml)** | 6 hour | 60.00 (40.00–120.00) | | 180.00 (70.00–280.00) | 0.001 |
| | 12 hour | 120.00 (50.00–150.00) | | 180.00 (100.00–250.00) | 0.001 |
| | 24 hour | 150.00 (70.00–200.00) | | 200.00 (130.00–280.00) | 0.01 |
| | **Time points** | **(within group)** | | | |
| | | **Median(IQR)** | ***p*-value** | **Median(IQR** | ***p*-value** |
| | 6 hour | 60.00 (35.00-120.00) | 0.001 | 180.00 (60.00-280.00) | 0.33 |
| | 12 hour | 120.00 (50.00-150.00) | | 180.00 (100.00-255.00) | |
| | 24 hour | 150.00 (65.00-215.00) | | 200.00 (130.00-280.00) | |

*TXA=Tranexamic acid*

In the present study, postoperative blood loss at 24 hours was lower in the TXA group compared with the control group [150.00(70.00–200.00) mL vs. 200 (130–280) mL; $p$=0.01]. This aligns with the results reported by Shah *et al.*,[8] who observed a markedly reduced 24-hour chest tube drainage in CABG patients receiving TXA (328.8±94.4 mL vs. 657.4±183.4 mL; $p$<0.001). Similarly, Chaudhry *et al.*,[12] demonstrated that in a cohort of 100 patients, the group receiving topical TXA had significantly lower blood loss by 48 postoperative hours compared with controls, while both groups were comparable in surgical characteristics and perioperative complications. These findings, together with our results, reinforce the effectiveness of topical TXA in minimizing postoperative bleeding.

There have been various studies on the post-operative outcomes for cardiac surgery bleeding when using TXA either topically, through IV, or using a placebo, and these have shown a variation in results. Previous studies in cardiac surgery have compared topical TXA and placebo, and have shown a trend of reduced bleeding in patients receiving topical TXA, which agrees with our results.[13-15] However, Wang *et al.*,[9] stated that there was no significant need for topical TXA in post-operative transfusions, and was shown to have no association with transfusions of blood, RBCs, FFP, or PLTs, which agrees with our study. Jagdish *et al.*,[16] also stated there was no significance in changing other factors such as post-operative serum hemoglobin levels, blood products transfusion, or the transfusion profiles. These results can be, at least in part, explained by the local effect of TXA on the surgical site which can cause a reduction in loss of blood systemically, and in turn, cause a reduction in the need for transfusions.

While intravenous TXA has been associated with higher risks of thromboembolism and early graft occlusion in CABG patients, topical TXA offers strong local antifibrinolytic action with minimal systemic absorption.[14,17] Different studies have shown that topical TXA effectively reduces bleeding in various surgeries without increasing adverse effects.[18,19] De Bonis *et al.*,[10] reported that instilling a 1% TXA solution into the pericardial cavity before sternal closure significantly reduced postoperative bleeding over 24 hours compared with placebo, consistent with our observations. Ayaz *et al.*,[20] demonstrated a statistically significant reduction in blood loss within the first 3 hours in the TXA group; however, this effect did not persist over the subsequent 24 hours. Our study showed similar findings, which may be due to the relatively low TXA concentration (1%), limiting sustained

inhibition of local fibrinolysis. Higher concentrations could potentially prolong the hemostatic effect and maintain bleeding reduction for a longer duration. Meta-analysis, reported that TXA administration did not significantly affect activated clotting time (ACT) values or the doses of heparin and protamine, while it significantly reduced postoperative blood loss and transfusion requirements in cardiac surgery patients.[21,22] our results are consistent with these findings, supporting the efficacy and safety of topical TXA in CABG surgery.

Topical TXA demonstrates significant clinical utility in on-pump CABG patients by effectively limiting postoperative bleeding and reducing the potential need for red blood cell transfusions. Unlike intravenous administration, topical TXA provides strong local antifibrinolytic effects with minimal systemic exposure, thereby lowering the risk of complications such as thromboembolism or early graft occlusion. Its application supports better perioperative hemostasis, helps prevent transfusion-related risks, and contributes to improved overall surgical outcomes, establishing it as a practical and safe adjunct in standard CABG procedures.

The findings of this study highlight that Topical TXA effectively reduces postoperative blood loss in on-pump CABG patients, with a trend toward lower red blood cell transfusion requirements, while other blood product usage and patient characteristics remained comparable. These findings are consistent with previous studies showing the local hemostatic effect of TXA and the limited systemic impact, explain why transfusion differences were often not statistically significant. Compared with intravenous TXA, topical administration offers the advantage of strong local antifibrinolytic action with minimal systemic absorption, reducing the risk of thromboembolic complications. Overall, the results support topical TXA as a safe and effective strategy to optimize perioperative hemostasis, minimize bleeding, and improve patient outcomes in CABG surgery.

## LIMITATIONS OF THE STUDY

There are multiple limitations with this study. Findings may not be widely applicable as this is a single-centered study. Even though the sample size was statistically powered, the conclusions of the study would be more robust with a larger cohort in future studies. The study focused more on short-term outcomes, specifically on postoperative blood loss and the need for transfusion. Long-term outcomes such as thromboembolic events or graft patency, were left out of the study. The absence of high-risk participants with considerable comorbidity, allowed for most a sample, but may restrict applicability to a larger patient population. Also, the effort made for the standardization of pre and postoperative protocols may have had unmeasured variables such as in individual surgeon style or intraoperative management that could have had an outcome on the findings. The design for future studies should include RCTs and be multi-centered, with larger and more varied patient populations, to enhance the generalizability of the findings. Future studies should consider the long-term outcomes of thromboembolic events and graft patency. Also, different dosages of TXA can be assessed to determine the optimal regimen for reducing blood loss. The generalizability of the findings would be improved with more multicenter studies, RCTs, and further standardization of perioperative protocols accounting for surgeon- or technique-related variability.

## CONCLUSION

In conclusion, topical TXA significantly reduces postoperative blood loss in on-pump CABG patients, with a trend toward lower red blood cell transfusion requirements. Other blood product usage and patient characteristics remained comparable between groups, suggested the observed benefits are due to the intervention. Topical TXA provides effective local hemostasis without notable systemic effects, making it a safe and practical strategy to minimize bleeding and improve perioperative outcomes. These findings support its routine use in CABG surgery.

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**Authors' Contribution**

Following authors have made substantial contributions to the manuscript:

SH & MAK: Concept, study design, drafting the manuscript, approval of the final version to be published.

SH & MUA: Concept, data acquisition, critical review, approval of the final version to be published.

AA ZUS: Data acquisition, data analysis, data interpretation, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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