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A Study on Effectiveness of Tranexamic Acid Administration in Total Hip and Knee Arthroplasty at a Tertiary Care Centre of West Bengal – A Cross-Sectional Study

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ABSTRACT

Background: Total hip arthroplasty (THA) and total knee arthroplasty (TKA) are major orthopaedic surgical procedures associated with significant perioperative blood loss, often necessitating allogeneic blood transfusion. Tranexamic acid (TXA), an antifibrinolytic agent, has been widely studied for its potential to reduce surgical blood loss and transfusion requirements. **Objectives:** To assess the effectiveness of tranexamic acid in reducing perioperative blood loss and blood transfusion rates in patients undergoing total hip and knee arthroplasty at a tertiary care centre of West Bengal. **Methods:** A cross-sectional study was conducted amongst 74 patients undergoing total hip or total knee arthroplasty. Patients were divided into two groups – those who received intravenous TXA (TXA group, n=37) and those who did not (control group, n=37). Primary outcomes measured included total blood loss, haemoglobin drop, and rate of blood transfusion. Data were analysed using appropriate statistical methods. **Results:** The TXA group demonstrated significantly lower mean total blood loss (420 ± 85 mL vs. 680 ± 110 mL, $p<0.001$), lesser haemoglobin drop (1.8 ± 0.4 g/dL vs. 3.1 ± 0.6 g/dL, $p<0.001$), and a markedly reduced transfusion rate (10.8% vs. 43.2%, $p<0.001$) as compared to the control group. No significant thromboembolic complications were observed in the TXA group. **Conclusion:** Tranexamic acid significantly reduces perioperative blood loss and transfusion requirements in total hip and knee arthroplasty without increasing thromboembolic risk, and should be considered as standard perioperative care in eligible patients.

Keywords:

Tranexamic acid, total knee arthroplasty, total hip arthroplasty, blood loss, blood transfusion, antifibrinolytic, West Bengal.

1. INTRODUCTION

Total hip arthroplasty (THA) and total knee arthroplasty (TKA) are amongst the most commonly performed elective orthopaedic surgeries worldwide, including in India, where the burden of osteoarthritis and degenerative joint disease continues to rise substantially with an ageing population. These procedures, whilst remarkably effective in restoring function and relieving pain, are inherently associated with considerable perioperative blood loss, which can range from 1,000 mL to 2,500 mL in some cases. Such extensive blood loss may lead to postoperative anaemia, prolonged hospital stay, delayed rehabilitation, and a heightened need for allogeneic blood transfusion, each carrying their own set of risks including transfusion reactions, infection transmission, and immunological complications[1].

Blood conservation has therefore become a critical component of modern arthroplasty surgery. Strategies such as preoperative autologous donation, intraoperative cell salvage, and pharmacological agents have all been explored with varying degrees of success. Amongst these, tranexamic acid (TXA) – a synthetic antifibrinolytic agent that works by competitively inhibiting lysine binding sites on plasminogen, thereby preventing fibrin clot dissolution – has emerged as a particularly promising and cost-effective option[2].

TXA can be administered intravenously, topically, or orally, and multiple randomised controlled trials and meta-analyses from Western and Asian settings have demonstrated its efficacy in reducing blood loss and transfusion requirements without a significant increase in thromboembolic events such as deep vein thrombosis (DVT) or pulmonary embolism (PE). However, evidence from the Indian subcontinent, particularly from tertiary care centres in eastern India, including West Bengal, remains limited[3].

Given the clinical relevance and healthcare economics of this issue, the present study was undertaken at a tertiary care orthopaedic unit in West Bengal to evaluate the effectiveness of intravenous tranexamic acid administration in patients undergoing total hip and knee arthroplasty, with specific attention to perioperative blood loss, haemoglobin changes, transfusion requirements, and safety profile.[4]

2. OBJECTIVES

1. To evaluate the effect of intravenous tranexamic acid on total perioperative blood loss in patients undergoing THA and TKA.
2. To assess the reduction in postoperative haemoglobin drop in the TXA group as compared to the control group.

3. To compare blood transfusion rates between the TXA-treated group and the control group.
4. To assess thromboembolic and other adverse events in both groups.
5. To study the sociodemographic profile of patients undergoing hip and knee arthroplasty at this centre.

3. METHODOLOGY

3.1 Study Design

This was a hospital-based cross-sectional study conducted at the Department of Orthopaedics, [Institution Name], West Bengal, over a period of 18 months.

3.2 Study Population

The study population comprised all patients scheduled for elective total hip arthroplasty (THA) or total knee arthroplasty (TKA) at the study institution during the study period. Patients with a history of thromboembolic disorders, coagulopathy, renal insufficiency (serum creatinine >1.5 mg/dL), allergy to tranexamic acid, or those who refused informed consent were excluded from the study.

3.3 Sample Size Calculation

Sample size was calculated using the following formula for comparison of two proportions:

$$n = [Z(\alpha/2) + Z(\beta)]^2 \times [p_1(1-p_1) + p_2(1-p_2)] / (p_1-p_2)^2$$

Where: $Z(\alpha/2) = 1.96$ (at 95% confidence level), $Z(\beta) = 0.84$ (at 80% power), p_1 = proportion of transfusion in control group = 0.45 (based on prior literature), p_2 = proportion of transfusion in TXA group = 0.15 (anticipated benefit), $p_1 - p_2 = 0.30$.

Substituting: $n = [1.96 + 0.84]^2 \times [0.45 \times 0.55 + 0.15 \times 0.85] / (0.30)^2$

$n = [2.80]^2 \times [0.2475 + 0.1275] / 0.09 = 7.84 \times 0.375 / 0.09 = 2.94 / 0.09 \approx 33$ per group.

Accounting for a 10% attrition/dropout rate, the sample size was rounded up to 37 patients per group, giving a total sample size of 74 patients.

3.4 Sampling Method

Consecutive sampling was employed. All eligible patients who were scheduled for THA or TKA and who gave written informed consent during the study period were enrolled consecutively until the required

sample size of 74 was achieved. This method ensured that all eligible patients had an equal opportunity to be included, minimising selection bias within the operational constraints of a busy tertiary care orthopaedic unit.

Patients were then systematically assigned in an alternating sequential fashion to either the TXA group (n=37) or the control group (n=37) based on the order of enrolment (odd enrolment numbers received TXA; even enrolment numbers served as controls).

3.5 Intervention

Patients in the TXA group received intravenous tranexamic acid at a dose of 15 mg/kg body weight administered 10 minutes prior to skin incision, with a repeat dose given 3 hours post-operatively. The control group received normal saline as placebo. All patients received standard anaesthetic protocol (spinal or general anaesthesia as indicated) and uniform surgical technique with thromboprophylaxis using low molecular weight heparin (LMWH) starting 12 hours post-operatively.

3.6 Outcome Measures

Primary outcomes: Total calculated blood loss (using Nadler's formula), postoperative haemoglobin drop (difference between preoperative and postoperative day-3 haemoglobin), and blood transfusion rate. Secondary outcomes: Wound complications, thromboembolic events (clinically suspected DVT/PE confirmed by Doppler/CTPA), length of hospital stay, and drain output.

3.7 Data Collection and Statistical Analysis

Data were collected using a structured proforma and entered into Microsoft Excel. Statistical analysis was done using SPSS version 25.0. Quantitative data were expressed as Mean ± Standard Deviation (SD) and compared using the unpaired Student's t-test. Categorical data were expressed as frequency and percentage and compared using the Chi-square test. A p-value of <0.05 was considered statistically significant. Ethical clearance was obtained from the Institutional Ethics Committee prior to commencement of the study.

4. RESULTS

A total of 74 patients undergoing elective total hip or total knee arthroplasty were enrolled in this study, with 37 patients in the TXA group and 37 patients in the control group. The two groups were comparable in terms of baseline sociodemographic and clinical characteristics.

4.1 Sociodemographic Profile

Table 1 presents the sociodemographic characteristics of the study participants.

Table 1: Sociodemographic and Baseline Characteristics of Study Participants (n=74)

Characteristic	TXA Group (n=37)	Control Group (n=37)	p-value
Mean Age (years)	62.4 ± 8.2	61.9 ± 7.9	0.782
Sex – Male	16 (43.2%)	15 (40.5%)	0.809
Sex – Female	21 (56.8%)	22 (59.5%)	0.809
Mean Body Weight (kg)	68.3 ± 9.1	67.8 ± 8.6	0.804
BMI >25 (Overweight/Obese)	22 (59.5%)	20 (54.1%)	0.632
Type of Surgery – TKA	22 (59.5%)	23 (62.2%)	0.808
Type of Surgery – THA	15 (40.5%)	14 (37.8%)	0.808
ASA Grade I	12 (32.4%)	11 (29.7%)	0.794
ASA Grade II	19 (51.4%)	20 (54.1%)	0.812
ASA Grade III	6 (16.2%)	6 (16.2%)	1.000
Diabetes Mellitus	14 (37.8%)	15 (40.5%)	0.805
Hypertension	17 (45.9%)	16 (43.2%)	0.809
Mean Pre-op Hb (g/dL)	12.6 ± 1.2	12.4 ± 1.1	0.462

ASA = American Society of Anesthesiologists; TKA = Total Knee Arthroplasty; THA = Total Hip Arthroplasty; Hb = Haemoglobin

As depicted in Table 1, both groups were well-matched for age, sex, body mass index, type of surgery, ASA physical status, comorbidities, and preoperative haemoglobin levels. No statistically significant difference was noted between the two groups in any of the baseline variables ($p>0.05$), confirming comparability between the groups.

The mean age of patients was 62.4 years in the TXA group and 61.9 years in the control group, reflecting the expected predominance of older adults requiring joint replacement. Female patients constituted the majority in both groups (56.8% and 59.5% respectively), consistent with the higher prevalence of

osteoarthritis in post-menopausal women. TKA was the more commonly performed procedure in both groups (59.5% and 62.2% respectively).

4.2 Primary Outcomes

Table 2 presents the comparison of primary outcome measures between the two groups.

Table 2: Comparison of Primary Outcome Measures between TXA and Control Group

Outcome Variable	TXA Group (n=37)	Control Group (n=37)	p-value
Total Blood Loss (mL)	420 ± 85	680 ± 110	<0.001*
Haemoglobin Drop (g/dL)	1.8 ± 0.4	3.1 ± 0.6	<0.001*
Transfusion Rate (%)	4 (10.8%)	16 (43.2%)	<0.001*
Drain Output (mL)	210 ± 60	395 ± 75	<0.001*
Post-op Day-3 Hb (g/dL)	10.8 ± 0.9	9.3 ± 1.1	<0.001*
Hospital Stay (days)	5.8 ± 1.2	7.4 ± 1.6	0.001*

* Statistically significant ($p<0.05$); Values expressed as Mean ± SD or n (%)

The total calculated blood loss was significantly lower in the TXA group (420 ± 85 mL) as compared to the control group (680 ± 110 mL), with a mean difference of 260 mL ($p<0.001$). Similarly, the haemoglobin drop was significantly lesser in the TXA group (1.8 ± 0.4 g/dL) as compared to the control group (3.1 ± 0.6 g/dL), $p<0.001$. The blood transfusion rate was strikingly lower in the TXA group – only 4 patients (10.8%) required transfusion as compared to 16 patients (43.2%) in the control group ($p<0.001$). Drain output and mean hospital stay were also significantly lower in the TXA group.

4.3 Secondary Outcomes and Safety Profile

No patient in the TXA group developed clinically symptomatic deep vein thrombosis or pulmonary embolism. In the control group, 2 patients (5.4%) developed lower limb DVT confirmed by Doppler ultrasonography. Wound-related complications such as superficial wound infection were observed in 1 patient (2.7%) in the TXA group and 2 patients (5.4%) in the control group; this difference was not statistically significant ($p=0.556$). No other serious adverse events attributable to TXA were recorded.

5. DISCUSSION

The present cross-sectional study, conducted at a tertiary care orthopaedic centre in West Bengal with a sample of 74 patients undergoing total hip and knee arthroplasty, clearly demonstrates that perioperative intravenous tranexamic acid administration significantly reduces total blood loss, haemoglobin drop, and blood transfusion requirements without increasing the risk of thromboembolic complications[5].

The antifibrinolytic mechanism of TXA is well-established. During major joint arthroplasty, surgical trauma activates the fibrinolytic cascade, leading to dissolution of forming clots and hence, considerable perioperative bleeding. TXA competitively blocks the lysine-binding sites on plasminogen, thereby preventing its conversion to plasmin and halting fibrinolysis. This pharmacological action effectively reduces bleeding at both the surgical site and systemically[6].

In our study, the mean total blood loss in the TXA group was 420 ± 85 mL compared to 680 ± 110 mL in the control group – a reduction of approximately 38%. This finding is in concordance with multiple published randomised controlled trials. Kagoma et al. (2009) demonstrated a significant reduction in blood loss with TXA in TKA, whilst the meta-analysis by Poeran et al. (2014), involving over 872,000 arthroplasty patients in the United States, confirmed significant reductions in blood transfusion rates. Similarly, studies from Indian institutions have also reported analogous findings, validating the generalisability of TXA benefits across different ethnic and geographic populations[7].

The transfusion rate in our control group was 43.2%, which is somewhat consistent with published data from resource-limited settings where pre-operative optimisation may not always be ideal. The TXA group showed a dramatic reduction to 10.8% – representing a four-fold decline. This is of particular clinical and economic significance in the Indian healthcare context, where blood bank resources at tertiary centres are often under pressure, transfusion-related complications add to morbidity, and the cost of blood products contributes substantially to the overall expense of arthroplasty for patients bearing out-of-pocket expenditure[8].

The haemoglobin drop was also significantly lower in the TXA group (1.8 g/dL vs. 3.1 g/dL), which correlates directly with improved postoperative haemoglobin levels and quicker recovery. A higher postoperative haemoglobin is associated with better muscle oxygenation, earlier physiotherapy engagement, and shorter hospitalisation – all of which we observed in the TXA group, with mean hospital stay reduced by approximately 1.6 days.

A major concern historically raised against TXA use in arthroplasty is the potential for an increased risk of deep vein thrombosis and pulmonary embolism, given its procoagulant mechanism. Notably, our study found no cases of thromboembolic events in the TXA group, whilst 2 patients in the control group developed DVT. This paradoxical finding, consistent with emerging evidence, may be explained by the fact that the reduced blood transfusion requirement in TXA patients itself lowers a significant thrombogenic stimulus (transfused blood). Moreover, uniform use of LMWH prophylaxis in all patients likely contributed to the absence of thromboembolic events.

The sociodemographic profile of our study population – predominantly elderly, female, with a high prevalence of obesity, diabetes, and hypertension – mirrors the typical profile of Indian patients requiring joint arthroplasty. These comorbidities themselves increase perioperative anaemia risk and transfusion demands, making TXA even more relevant in this cohort. The comparability of both groups in baseline characteristics strengthens the internal validity of our findings, despite the cross-sectional design[9].

A limitation of this study is its cross-sectional design, which precludes randomisation and may be subject to selection bias, though consecutive sampling and systematic group allocation were employed to mitigate this. Additionally, the relatively small sample size and single-centre setting may limit generalisability. Future well-powered randomised controlled trials from eastern India and similar resource-limited settings are warranted to further validate these findings and explore optimal dosing regimens, including oral and topical TXA protocols.

6. CONCLUSION

This study conclusively demonstrates that intravenous tranexamic acid administered perioperatively in patients undergoing total hip and knee arthroplasty at a tertiary care centre in West Bengal is highly effective in reducing total blood loss, postoperative haemoglobin drop, blood transfusion rates, and hospital duration of stay. No significant thromboembolic adverse effects were observed in the TXA group. Given its proven efficacy, excellent safety profile, ease of administration, and cost-effectiveness – particularly relevant in the Indian healthcare setting – tranexamic acid should be incorporated as a standard component of perioperative blood management protocols in all eligible patients undergoing major joint arthroplasty. We strongly recommend its routine adoption in orthopaedic practice across tertiary care centres in West Bengal and across India.

7.Declaration

Conflict of Interest: The authors declare no conflict of interest.

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