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Original Article

ROLE OF TRANEXAMIC ACID IN CONTROLLING BLOOD LOSS IN TOTAL HIP ARTHROPLASTY

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ABSTRACT

Objective: The incidence of total hip arthroplasty (THA) is on the rise, often resulting in significant blood loss. It has been observed that Tranexamic acid (TXA) can diminish the blood loss experienced during the perioperative period of hip joint arthroplasty. Nonetheless, the optimal method of administering TXA remains a topic of debate. So, we studied the role of Tranexamic Acid in Controlling Blood Loss in Total Hip Arthroplasty.

Methods: In Prospective group data: By giving a dose of 15 mg/kg of Tranexamic acid, intravenously 15 min before given incision and 15 mg/kg topically after the closure of the hip joint capsule. Retrospective data from the records of previous patients who were administered intravenous tranexamic acid while undergoing THR in the past 3 years with 30 cases in each group. Information was gathered regarding the volume of blood loss, levels of hemoglobin, frequency of transfusions, and the incidence of deep vein thrombosis and pulmonary embolism.

Results: The mean operation times were approximately 43.5±9.0 min and 42.2±8.0 min in group A and group B, respectively. The operation time and intra-operative blood loss show insignificant differences in prospective and retrospective groups. The post-operative blood loss, total blood loss, and decrease in haemoglobin level depicted insignificant differences in prospective and retrospective groups. There were insignificant differences in terms of blood loss and systemic complications between tranexamic acid administration methods.

Conclusion: Tranexamic acid is effective in minimizing blood loss following surgery as well as the overall blood loss associated with total hip arthroplasty, according to the data reviewed and the results of this study showing non-inferior efficacy of topical TXA and IV TXA with IV TXA, we proposed that topical administration of 15 mg/ml of TXA before wound closure was a simple, safe, feasible and effective prophylactic measure with minimal adverse effects. The use of this method proved to be economical, effectively decreasing bleeding, diminishing the necessity for additional blood transfusions, and averting the possibility of surgical intervention due to excessive bleeding.

Keywords: Intravenous, Topical, Total hip arthroplasty, Tranexamic acid, Blood loss

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INTRODUCTION

Total hip arthroplasty (THA) is a critical surgical procedure for advanced hip conditions, projected to increase significantly by 2030.[1] However, THA often results in substantial blood loss, leading to complications and potentially requiring allogeneic blood transfusions [2]. These transfusions, while essential, can escalate costs and hospital stays and pose risks such as infections and cardiovascular complications [3, 4]. Tranexamic acid (TXA), a synthetic amino acid analogue, inhibits plasminogen activation and fibrinolysis, thereby reducing blood loss [5]. TXA has demonstrated efficacy in various surgeries and is increasingly used in THA to lower blood loss and transfusion rates [6]. Studies, including randomized controlled trials, endorse both intravenous and topical TXA administration, showing no significant increase in complications like deep vein thrombosis or wound infections [7, 8]. The optimal delivery method for TXA remains debated, particularly in comparing intravenous (IV) versus topical application in THA [9]. IV TXA may be restricted by conditions such as renal insufficiency or a history of thrombosis, prompting an investigation into topical TXA as a potentially safer alternative at the surgical site. Initial findings suggest that topical TXA is ineffective in reducing blood loss during THA [10].

"In conclusion, TXA presents a valuable option for managing blood loss during THA. Our research question focuses on assessing the potential of tranexamic acid (TXA) in effectively managing blood loss during total hip arthroplasty (THA), and exploring methods to optimize its delivery for enhanced patient outcomes and safety."

MATERIALS AND METHODS

This ambispective study was conducted in the Department of Orthopaedics at a tertiary care hospital in central India, involving patients who underwent total hip arthroplasty. The study, approved by the institutional ethical committee, included patients who provided written informed consent. The prospective group comprised patients who had surgery between May 2023 and November 2023, while the retrospective group included data from patients who underwent the procedure within the past three years.

Inclusion criteria included patients over 18 y of age undergoing primary unilateral total hip arthroplasty. Exclusion criteria included a history of coagulation or bleeding disorders, deranged coagulation profiles, thromboembolic disorders such as deep vein thrombosis or pulmonary embolism, hepatic or renal anomalies, known cardiovascular diseases, allergies to tranexamic acid, a history of stroke or transient ischemic attacks, and patients with incomplete records.

Prospective Group (Group A): This group consisted of 30 patients scheduled for total hip arthroplasty. They received an intravenous dose of tranexamic acid at 15 mg/kg, with a maximum dose of 1 g, administered 15 min before the incision. This timing ensures adequate circulation of the drug, allowing its anti-fibrinolytic effects to be fully active by the start of the surgery. Additionally, an intracapsular dose of 15 mg/kg, with a maximum dose of 1 g, was given after the water-tight closure of hip capsule.

Retrospective Group (Group B): This group included data from 30 patients who had undergone total hip arthroplasty in the past three years. These patients also received an intravenous dose of tranexamic acid at 15 mg/kg, with a maximum dose of 1 g, administered 15 min before the incision.

After obtaining patient consent, baseline characteristics were recorded, including preoperative complete blood count (CBC), hemoglobin (HB), and packed cell volume (PCV) for calculating blood loss using the Gross and Nadler formula. Intraoperative blood

loss was assessed through vacuum suction and surgical mops, while postoperative blood loss was measured from drain collection at 24 and 48 h. Additionally, a postoperative CBC was conducted on the second day, and all data were systematically documented in our operating records.

The study compared intraoperative blood loss between the two groups.

Statistical analysis

Data were organized and visualized using Microsoft Excel, while statistical analysis was carried out using SPSS version 23 for Windows. Quantitative data that followed a normal distribution were summarized using the mean and standard deviation (±SD). To compare continuous variables between two independent groups, the parametric independent Student's t-test was used. For categorical variables, the chi-square (χ^2) test was applied. Statistical significance was set at a p-value of less than 0.05 ($p<0.05$).

RESULTS

In this bidirectional study total 60 patients were included with 30 each in both group (prospective and retrospective) as per our inclusion/exclusion criteria.

Table 1: Baseline characteristics of patients of both groups

Variables	Group A (n=30) (%)		Group B (n=30) (%)	p-value
Age in years	63.6±9.7		64.9±10.5	0.714
Gender	Male	8 (26.7)	9 (30.0)	0.679
	Female	22 (73.3)	21 (70.0)	
Side	Right	16 (53.3)	18 (60.0)	0.662
	Left	14 (46.7)	12 (40.0)	
BMI (Kg/m2)	24.5±4.0		24.6±3.7	0.987
Preoperative Hb (g/dL)	13.2±1.3		13.3±1.2	0.916

For the variables analyzed, Group A (n=30) and Group B (n=30) showed the following results: The average age of patients in Group A was 63.6 y (±9.7), while in Group B it was 64.9 y (±10.5). The p-value for this difference was 0.714, indicating no significant difference between the two groups. In terms of gender distribution, Group A comprised 8 males (26.7%) and 22 females (73.3%), whereas Group B included 9 males (30.0%) and 21 females (70.0%). The p-value for gender differences was 0.679.

Regarding the side of the surgery, 16 patients (53.3%) in Group A had the procedure on the right side, compared to 18 patients (60.0%) in Group B. The p-value for this side distribution was 0.662. The body mass index (BMI) was 24.5±4.0 kg/m^2 in Group A and 24.6±3.7 kg/m^2 in Group B, with a p-value of 0.987, suggesting no significant difference.

Preoperative hemoglobin levels were 13.2±1.3 g/dl in Group A and 13.3±1.2 g/dl in Group B. The p-value for hemoglobin levels was 0.916, indicating no significant difference between the groups.

In comparing the two groups, the mean operative time was 43.5±9.0 min for Group A and 42.2±8.0 min for Group B, with a p-value of 0.214, indicating no significant difference between the groups. The decrease in hemoglobin on Day 1 was 1.8±0.8 g/dl in Group A and 1.9±0.9 g/dl in Group B, with a p-value of 0.650, showing no significant difference. Similarly, the decrease in hemoglobin on Day 2 was 2.1±0.9 g/dl in Group A and 2.2±0.9 g/dl in Group B, with a p-value of 0.669, which also showed no significant difference.

In terms of intraoperative blood loss, Group A had an average of 290.3±124.1 ml, while Group B had 298.7±113.0 ml. The p-value for this measure was 0.785, suggesting no significant difference between the groups. Postoperative blood loss averaged 240.6±127.1 ml in Group A and 265.9±129.8 ml in Group B, with a p-value of 0.449, again indicating no significant difference. Total blood loss was 531.9±130.3 ml in Group A compared to 564.6±131.6 ml in Group B, with a p-value of 0.337, showing no significant difference between the two groups.

Table 2: Perioperative outcomes of patients who had undergone total hip arthroplasty

Variables	Group A (n=30)	Group B (n=30)	p-value
Operation time (min)	43.5±9.0	42.2±8.0	0.214
Decrease in Hb Day 1	1.8±0.8	1.9±0.9	0.650
Decrease in Hb Day 2	2.1±0.9	2.2±0.9	0.669
Intraoperative blood loss (ml)	290.3±124.1	298.7±113.0	0.785
Post-operative blood loss (ml)	240.6±127.1	265.9±129.8	0.449
Total Blood loss (ml)	531.9±130.3	564.6±131.6	0.337

Table 3: Rates of blood transfusion and incidence of thromboembolic events in patients who had undergone total hip arthroscopy

Variables	Group A (n=30)	Group B (n=30)	P value
Blood transfusion	1 (3.3%)	2 (6.7%)	0.554
Deep vein thrombosis	0 (0.0)	1 (3.3)	0.313
Pulmonary embolism	0 (0.0)	0 (0.0)	1.000
Complications (AKI or MI)	1 (3.3)	2 (6.7%)	0.554

In the analysis of complications between the two groups, Group A had 1 patient (3.3%) who required a blood transfusion, compared to 2 patients (6.7%) in Group B, with a p-value of 0.554, indicating no significant difference. Deep vein thrombosis was observed in none patients (0.0%) in Group A and in one patient (3.3%) in Group B, with a p-value of 0.313, showing no significant difference. There were no cases of pulmonary embolism in either group, with a p-value of 1.000. Additionally, complications such as acute kidney injury (AKI) occurred in 1 patient (3.3%) in Group A and in 2 patients (6.7%) in Group B, with a p-value of 0.554, which also indicates no significant difference between the groups.

DISCUSSION

Perioperative hemorrhage remains a significant challenge in surgical management, particularly in procedures like total hip arthroplasty. One of the key factors contributing to this is the increased activity of

fibrinolytic agents and the affected clotting ability of the blood during surgery [11]. Hemostasis is facilitated through catecholamines' effects on platelet function, alongside elevated levels of coagulation factors and a reduction in the efficacy of coagulation inhibitors [12].

Tranexamic acid (TXA), an antifibrinolytic agent, has been extensively used across various surgical disciplines to minimize blood loss during the perioperative period, reduce the need for blood transfusions, and prevent hematoma formation [13]. However, the optimal route of administration and the most effective dosage of TXA remain subjects of ongoing debate.

Previous studies have primarily focused on intravenous (IV) administration of TXA to control bleeding during surgery and reduce blood transfusion needs. Some researchers have also investigated the topical application of TXA directly to the surgical site to achieve similar benefits while minimizing systemic hypercoagulation effects [14, 15]. Despite these efforts, the effectiveness and safety of topical TXA application are still not conclusively established in the literature [16].

In our study, we observed that the mean age of patients in Group A was 63.6±9.7 y, and in Group B, it was 64.9±10.5 y, with a predominance of females in both groups. The majority of surgeries were performed on the right side, and preoperative hemoglobin levels were 13.2±1.3 g/dl for Group A and 13.3±1.2 g/dl for Group B. These differences were not statistically significant, consistent with findings by Uneo M *et al.*, who reported no significant differences in height, weight, body mass index, or preoperative hemoglobin levels across similar patient groups [17]. Patel JN *et al.* also found no notable differences in age, gender, BMI, or side of surgery, aligning with our results [10].

Our study found that the average operative time was similar between the groups, and the mean decrease in hemoglobin on both Day 1 and Day 2 was slightly higher in the retrospective group compared to the prospective group, though the differences were not statistically significant. Additionally, intraoperative and postoperative blood loss were higher in the retrospective group, but these differences were not significant. Total blood loss was 531.9±130.3 ml in the prospective group and 564.6±131.6 ml in the retrospective group, with no significant difference.

The average duration of operations was around 40 min for both groups, which was notably shorter than previous reports [18]. Uneo M *et al.* observed higher levels of blood loss and greater reductions in hemoglobin in control groups compared to those receiving topical or IV TXA treatments [17]. Our standardized surgical procedures and reduced operation times likely contributed to decreased blood loss compared to previous studies. Patel JN *et al.* reported no significant differences in hemoglobin levels or overall drainage output between topical and IV TXA groups, which is consistent with our findings [10].

Regarding postoperative complications, Group A experienced fewer issues, with only one case of blood transfusion and one case of acute kidney injury (AKI) or myocardial infarction (MI). In contrast, Group B had two cases each of blood transfusion and AKI, and one case of deep vein thrombosis (DVT), although these differences were not statistically significant. Uneo M *et al.* similarly found no significant disparities in transfusion rates or complication frequencies between groups. Patel JN *et al.* reported a few instances of AKI and MI, with patients recovering fully without additional complications. A recent meta-analysis supports the use of topical TXA, noting its effectiveness in reducing blood transfusions without significant adverse effects [19].

LIMITATIONS

This study has several limitations. The effectiveness of topical TXA largely depends on the watertight closure of the capsulotomy wound, surgical approach, intraoperative hemostasis, vitals and trauma to hip fracture leading to an injured hip capsule of patients. Consequently, the blood loss observed in this study may be underestimated. Additionally, the estimated blood loss is derived using an indirect method, which involves comparing preoperative hemoglobin levels with serial postoperative hemoglobin readings. Further research may be needed to refine dosing protocols and administration routes to optimize patient outcomes.

CONCLUSION

Our analysis demonstrates that Tranexamic acid (TXA) effectively reduces both blood loss during and cumulative blood loss after total hip arthroplasty (THA). We found no significant differences in blood loss or systemic complications between various TXA administration methods. Notably, using a smaller dose of topical TXA alongside intravenous (IV) administration proved more effective in reducing blood loss compared to using topical TXA alone.

Based on our findings, we recommend administering TXA intravenously before the surgery and topically after closing the hip joint capsule. Additionally, proper repair of the posterior soft tissue is advised to further minimize THA-related complications. The topical application of TXA at a concentration of 15 mg/ml, applied before wound closure, offers a straightforward, safe, and effective preventive strategy with minimal side effects. This approach is also cost-effective, as it reduces bleeding, decreases the need for additional blood transfusions, and helps avoid further surgical interventions due to hemorrhage.

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AUTHORS CONTRIBUTIONS

All the authors have contributed equally.

CONFLICTS OF INTERESTS

Declared none

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