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Use of tranexamic acid in primary hip arthroplasty: a retrospective audit of blood loss and transfusion rates

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ABSTRACT

Background: Tranexamic acid (TXA) is an anti-fibrinolytic agent that has shown promise in reducing blood loss during total hip arthroplasty (THA). Several studies have reported the significance of blood loss reduction and the reduction in the number of blood transfusions, thereby reducing transfusion- related injuries and enhancing patient recovery. The concern about the use of tranexamic acid is the venous thromboembolic effect it may possess. We aimed to study the efficacy and safety of this anti-fibrinolytic medication in primary total hip arthroplasty.
Methods: We conducted a retrospective chart review of 130 primary total hip arthroplasty (THA) performed from June 2023 to June 2025 at a single arthroplasty centre in South Korea by a single renowned arthroplasty surgeon. Surgical patients received 1 g intra-venous (IV) TXA half hour before the surgery followed by 2g intra-articular (IA) TXA during the surgery through a hemobag line. We analysed differences in haemoglobin (Hb), haematocrit (Hct), blood loss (BL), and adverse events in these patients.
Results: The mean age was 61.3 years, and the mean BMI was 21.5 kg/m². All patients received 3g TXA. The mean blood loss was 550 ml, and mean hemoglobin drop after surgery was 1.13 g/dl. Strong positive correlation was found between blood loss and transfusions ($r=0.726$, $p<0.001$). Twenty-one adverse events were reported.
Conclusions: Administration combined intravenous (IV) and intra-articular (IA) TXA does not appear to increase rates of adverse events and may be effective in minimizing blood loss, thereby minimizing the number of blood transfusions as reflected by Hb and Hct values following THA.

Keywords: Anti-fibrinolytics, Blood saving measures, Haematocrit, Haemoglobin, Total hip arthroplasty, Tranexamic acid

INTRODUCTION

Patients undergoing total hip arthroplasty (THA) face high-risk of surgical blood loss, in addition to significant hidden blood loss caused by bleeding into tissue and hemolysis causing blood loss in volumes ranging from 700 to 1500 ml.[1-3] Perioperative anemia (<11.0 g/dl for females and <12.0 g/dl for males) is, in turn, associated with increased morbidity and mortality.[4,5] Allogenic blood transfusion (ABT) to treat perioperative anemia is required in 10 to >31% of THA procedures and carries with it a risk of infection, incited immune responses, transfusion-related acute lung injury (TRALI), transfusion-associated sepsis (TAS), hemolytic transfusion reactions (HTR), cancer reoccurrence, prolonged hospital length of stay (LOS) and renal damage.[6,7] Postoperative risk of infection is increased by 0.1% per unit transfused, with more risk in immunocompromised patients.[8] Research into pharmacological modalities of controlling intra- and post-operative bleeding has intensified in recent years. One such pharmacologic area of inquiry is tranexamic acid (TXA).[9] Upon activation of the fibrinolytic pathway,

plasminogen is converted to fibrinolytic plasmin via tissue plasminogen activator (t-Pa). The intravenous (IV) formulation of TXA is a synthetic lysine derivative acting through competitive inhibition of lysine binding sites on plasminogen, thereby reducing the local degradation of fibrin clots by plasmin.[10-13] Consequently, TXA is a prime candidate for minimizing cases of postoperative anemia and, ultimately, decreasing transfusion rates. However, the optimal TXA dosage, whether TXA dosage should be weight based, and the ideal timing and route of TXA administration are subjects of continuous contention, with conflicting study findings present throughout the literature.[14]

The IV and IA route of administration remains the enduring clinical standard, limiting not only overt blood loss but also bleeding into the surrounding tissue.[15] Based upon these and several other trials, IV and IA TXA appears to be safe for use during orthopedic procedures and may be capable of significantly reducing total blood loss, dips in Hb and transfusion rates.[16,17]

To further evaluate the benefits of IV and IA TXA, we conducted a retrospective chart review to compare pre-operative hemoglobin (Hb) and hematocrit (Hct), transfusion rates, complications and immediate postoperative outcomes of patients at our centre receiving bolus IV TXA, followed by IA TXA during primary THA.

METHODS

Following institutional review board (IRB) approval, a retrospective study of primary THA cases performed by a single surgeon from June 2023 till June 2025 were reviewed by accessing electronic medical records (EMR). A total 0f 130 patients were studied. Each patient's chart was examined to determine whether the patient met the inclusion or exclusion criteria.

The review included patients over 18 years of age undergoing a primary THA procedure with preoperative Hb values ≥11 g/dl and normal international normalized ratios (INR), prothrombin times (PT) and partial thromboplastin time (PTT) values. Exclusion criteria included patients were younger than 18 years of age, underwent revision THA, hemiarthroplasty or bilateral THA procedures, had abnormal coagulation profiles, including elevated INR, PT or PTT values, had a known allergy or contraindication to TXA, had a history of thromboembolic disease, including deep vein thrombosis (DVT), pulmonary embolism (PE), cerebrovascular accident (CVA) or myocardial infarction (MI) within the recent past, had severe renal impairment or hepatic dysfunction, were receiving chronic anticoagulant therapy that could not be appropriately discontinued perioperatively. Patients' charts were screened for demographics (age, gender, body mass index BMI, American Society of Anaesthesiologists (ASA) score), dose and timing of TXA received and route of administration, Hb and Hct values at baseline and following surgery (postoperative day 1), blood transfusions and units of blood transfused. The occurrence of other adverse events were also recorded.

Surgical management

All procedures took place at The Bumin Hospital, Busan. For patients receiving TXA, a 1 g bolus was administered intravenously 30 mins prior to the surgery, followed by 2g TXA was administered into the operative site intra-articularly via hemobag line.

The surgeon used a posterior approach for all primary THA procedures. Postoperatively, a hemovac was connected to the drain positioned at the site of the surgical wound to assist with blood and fluid removal. Based on progress notes, compressive stockings were prescribed for the duration of their postoperative hospital stay. To prevent thrombosis, prophylactic anticoagulant medications were given to patients after surgery. Chart reviews demonstrated a general trend in the threshold for transfusion based on hemoglobin levels. Generally, for patients without cardiovascular disease, blood transfusions were administered for Hb values below 7 g/dl. Patients with cardiovascular disease and patients who did not tolerate low Hb values were transfused at Hb levels of <8 g/dl and <10 g/dl, respectively.

Statistical methods

Continuous demographic and clinical variables were summarized and evaluated using Student-t test. The differences for categorical variables were tested using chi-square or Fisher's exact tests. Multivariate linear mixed models with random intercepts were fit to compare each of the continuous hemoglobin and hematocrit outcomes, adjusting for potential confounders and other clinical variables and including appropriate interaction terms. P values <0.05 were considered to be statistically significant. All statistical analyses were performed in SPSS software.

RESULTS

A total of 130 patients were included. The mean age was 61.3+14.1 years and the mean BMI was 21.5+3.6 kg/m^2. Most patients were ASA grade II (n=94) and a minority were ASA III (n=7).

Sex distribution

The number of males and females in the study were evenly distributed as 66 patients and 64 patients respectively. Preoperative hemoglobin and hematocrit averaged 13.4±1.4 g/dl and 40.3±4.1 %, respectively. Postoperatively, these decreased to 12.3±1.1 g/dl and 36.4±3.9 %, indicating a mean hemoglobin drop of 1.13 g/dl and hematocrit drop of 3.86 %. Average intraoperative blood loss was 550 ml. The average operative duration was 106±98 minutes, with a mean PRBC transfusion of

1.38±0.66 units. Coagulation tests were within normal ranges.

Table 1: Sex distribution.

Sex	Number	Percentage (%)
Male	66	50.5
Female	64	49.5

Pearson correlation showed significant relationships between blood loss and transfusion (r=0.726, p<0.001), and pre-op Hb and Hb drop (r=0.662, p<0.001). Adverse events occurred in 5 patients. The patients had a mean age of 61.27 years (range: 24-87 years). The mean pre-operative haemoglobin was 13.44 g/dL (range: 10.5-17.6 g/dL), while the mean pre-operative haematocrit was 40.27% (range: 32.5-52.5%).

The mean intraoperative blood loss was 549.75 ml (range: 200-1200 ml), and the mean surgical duration was 105.66 minutes (range: 90-300 minutes). Post-operatively, the mean haemoglobin level was 12.36 g/dl (range: 9.3-15 g/dl) and the mean haematocrit was 36.69% (range: 28.9-45%). The mean body mass index (BMI) was 21.54 kg/m². Regarding ASA physical status classification, the majority of patients were ASA II (94.0%), followed by ASA III (5.0%) and ASA I (1.0%). Post-operative complications were observed in 10 patients.

Table 2: Transfusion group.

Transfusion group	Patients	Mean blood loss (ml)	Mean pre-op Hb	Mean pre-op HCT	Mean post-op Hb	Mean post-op HCT
0 PRBC	13	355-435	14.2	41.9	12.7	37.74
1 PRBC	100	477-675	13.6	40.8	12.4	36.83
2+PRBC	17	799-1000	12.7	38.3	11.7	34.88

Transfusion group

The table depicts the patients with the number of blood transfusions done, including their pre- operative and post-operative blood parameters and shows that 13 patients did not require any blood transfusion, 100 patients required one PRBC transfusion and 17 patients required two or more PRBC transfusions.

Table 3: Correlation of surgical duration with blood loss, transfusion and blood parameters.

Duration (min)	Variable 2	Correlation coefficient (r)	P value
Duration	Blood loss ml	-0.009	0.933
Duration	Transfusion units	-0.015	0.8809
Duration	Post op Hb	-0.139	0.1711
Duration	Post op HCT	-0.215	0.0329

Correlation of surgical duration with blood loss, transfusion and blood parameters

The duration of surgery and blood loss, the number of transfusions and blood volume parameters of post- op Hb and post- op Hct showed no significant correlation to each other.

Correlation of blood loss with transfusion and blood parameters

The blood loss (ml) during surgery and transfusion of blood showed significant correlation. The blood loss and post-op Hb and Hct also showed a significant correlation with the usage of tranexamic acid.

Table 4: Correlation of blood loss with transfusion and blood parameters.

Variable 1 (ml)	Variable 2	Correlation coefficient (r)	P value
Blood loss	Transfusion units	0.711	0.02
Blood loss	Post op Hb	-0.275	0.0058
Blood loss	Post op HCT	-0.203	0.0438

Correlation of transfusion units with pre-op and post-op Hb

There was a significant correlation between intra-op blood loss, transfusion units and post-op Hb and Hct with the usage of tranexamic acid.

Table 5: Correlation of transfusion units with pre-op and post-op Hb.

Variable 1	Variable 2	Correlation	P value
Transfusion units	Post op Hb	-0.318	0.0014
Transfusion units	Post op HCT	-0.227	0.0241

Post-operative complications

A total of 5 patients had post-operative complications. One patient had deep vein thrombosis (DVT). Three patients had fever. One patient had hyponatremia.

DISCUSSION

THA is associated with significant intraoperative and postoperative blood loss, often necessitating allogeneic blood transfusions.[18] Blood transfusions, while life-saving, carry risks such as immunologic reactions, transmission of infections and increased healthcare costs. As a result, strategies to minimize perioperative blood loss and reduce the need for transfusions are important. One such strategy is the administration of TXA, a synthetic lysine analogue that inhibits fibrinolysis by blocking the lysine binding sites on plasminogen molecules, thereby stabilizing clot formation.[19]

The average blood loss after a total hip arthroplasty range between 726-1768 ml as described in multiple studies by Hays et al, Billote et al and Charrois et al, without the use of TXA.[20-22] The factors such as mean operative duration, surgeon expertise, pre -operative blood volume parameters were measured by them. A study by Sefa Akti et al compared the blood loss incurred in total hip arthroplasty, with intra– operative blood loss volumes ranging from 400 ml to 1600 ml with administration of tranexamic acid. It also compared the blood loss from those patients receiving tranexamic acid and those who did not and showed that the blood loss decreased by 400 ml on average after using tranexamic acid.[23] This finding of average blood loss and the decrease in number of blood transfusions were consistent and similar to our study, highlighting the reduced blood loss and minimizing post- operative complications and blood transfusion related complications. In this study, the administration of 3 grams of TXA IV and IA, demonstrated a clinically and statistically significant reduction in total blood loss and the requirement for blood transfusions in patients undergoing primary THA. This dosage, administered in divided doses (commonly as 1g IV before incision, 2 g IA intra-operatively via a hemobag line), ensures sustained anti-fibrinolytic activity throughout the perioperative period.

Our findings align with multiple prior studies and meta-analyses that have consistently supported the efficacy of TXA in hip arthroplasty. For example, studies by Zufferey et al and Sukeik et al reported significant reductions in blood loss and transfusion requirements with TXA use, although dosages and routes of administration varied. The current use of a total 3 g dose may provide a more prolonged and effective suppression of fibrinolytic activity compared to single-dose and double-dose regimens, especially in surgeries with extended operative times or in patients with higher bleeding risk.[24,25] Our findings are consistent with current literature supporting the use of TXA in THA. In a comprehensive network meta-analysis by Fillingham et al, strong evidence was demonstrated for the efficacy of TXA in reducing blood loss and the need for transfusion following primary THA. The study included 34 trials and showed that TXA in different formulations, topical, intravenous and oral, were effective when compared to placebo. However, no particular route, dose, or timing strategy was found to be clearly superior than the other.[26] These results have supported major clinical practice guidelines from leading orthopedic and anaesthesiology societies. Similar to those findings, our study showed that TXA significantly reduced transfusion rates and post-operative decreases in hemoglobin and red blood cell volumes. In an umbrella review by Ghorbani et al, the efficacy and safety of TXA in THA were comprehensively evaluated based on 23 meta-analyses covering data from over 35,000 patients. The findings demonstrated that TXA significantly reduces perioperative blood loss (by 151-370 ml), postoperative hemoglobin drop (by 0.5-1.1 g/dl), and transfusion requirements (by 19-26%) compared to control groups. Notably, TXA administration was not associated with an increased risk of venous thromboembolism or wound complications. Furthermore, no substantial differences in outcomes were found across different dosages, modes of administration, or when TXA was used in combination with other anti-fibrinolytic agents.[27] These results reinforce the favourable risk–benefit profile of TXA in THA and support its routine use in clinical practice.

Additional insights into the safety profile of TXA in THA have been provided by a recent large-scale retrospective cohort study by Thapaliya et al utilizing the TriNetX Research network, which included adult patients undergoing THA between 2003 and 2024. The analysis compared outcomes between patients receiving TXA within 24 h prior to surgery and those who did not. At both 30 and 90 days postoperatively, TXA was associated with a significantly reduced risk of transfusion, deep vein thrombosis and peri-prosthetic joint infection. However, the study also reported higher rates of peri-prosthetic fractures (RR:1.2; 95% CI:1.09-1.36), acute postoperative anemia and both superficial and deep surgical site infections in the TXA cohort.[28] A meta- analysis done by Tan et al found no significant difference in blood loss or transfusion rates between IV and IA TXA, but topical TXA was associated with a lower incidence of systemic complications, suggesting enhanced safety.[29] In a prospective study by Seo et al, IA TXA at 3 g was found to be as effective as IV TXA, with no increase in postoperative DVT or wound complications and stated that IA TXA avoids first-pass hepatic metabolism and achieves high concentrations directly at the bleeding site, making it particularly useful in patients with a history of thromboembolism or contraindications to systemic anti-fibrinolytics.[30] Recent studies have also evaluated combined IV and IA TXA regimens to maximize efficacy. Xu et al found that a combined approach (1 g IV pre-incision+1 g IA before closure) yielded the lowest total blood loss compared to either method alone.[31] Importantly, no difference in DVT rates was observed between groups, underscoring the safety of multimodal TXA administration under proper thromboprophylaxis. Theoretical concern with TXA use is its prothrombotic potential. However, most evidence indicates that TXA does not increase the risk of DVT or pulmonary embolism (PE) when used in appropriate doses and alongside standard prophylaxis. The CRISTAL Trial (NEJM, 2022), a large multicenter RCT

of 4,131 patients undergoing hip or knee arthroplasty, showed that IV TXA significantly reduced transfusion rates without increasing DVT or pulmonary embolism (PE) events.[32] In our study, we used 3 g of tranexamic acid-1g IV half an hour prior to surgery and followed by 2 g intra- articularly via a hemobag line nearing the end of surgery. There was only one patient who had developed DVT. These findings suggest that TXA remains a highly effective agent for minimizing blood loss and thromboembolic risk. Future research should aim to clarify the clinical significance of these findings and identify patient subgroups that may be at higher risk for such adverse events.

Reducing the need for allogeneic blood transfusion offers several well-established benefits. Clinically, transfusion avoidance reduces the risk of transfusion-related complications such as febrile non-hemolytic reactions, hemolysis, allergic responses, TRALI, immunomodulation and transmission of infections such as HIV or hepatitis viruses.[33-35] Some studies have also reported a correlation between perioperative transfusion and increased rates of postoperative infections and delayed recovery. Limiting transfusion demand reduces the burden on blood bank logistics and improves work efficiency in perioperative care.[36] Beyond its well-established role in reducing perioperative blood loss, TXA may also exert anti-inflammatory effects, which could further benefit postoperative recovery. Recent evidence suggests that TXA administration, particularly in multi-dose regimens, can attenuate systemic inflammatory responses after joint arthroplasty. A meta-analysis by Poeran et al, described the efficacy and safety of tranexamic acid administration.[37] A retrospective study by Irisson et al, which compared patients undergoing hip and knee arthroplasty before and after the implementation of a standardized TXA protocol, demonstrated a marked reduction in blood transfusion requirements.[38]

Additionally, the use of multi-dose TXA was associated with a shorter length of hospital stay, with no significant increase in thromboembolic complications. These findings suggest that the benefits of TXA may extend beyond hemostatic control, potentially contributing to improved postoperative outcomes through modulation of inflammation. However, high-quality, large-scale studies are warranted to confirm and better understand the clinical significance of these effects. In our study, the observed reduction in transfusion rates is clinically significant. Not only does it reduce exposure to donor blood and associated complications, but it also contributes to faster postoperative recovery and shorter hospital stays, thereby improving overall patient outcomes and reducing healthcare burden.

Limitations

This study includes its retrospective nature. There was no comparison group to know the significant outcomes of the drug during total hip arthroplasty in the same hospital.

CONCLUSION

The administration of 3g tranexamic acid through a combined intra-venous and intra-articular in primary total hip arthroplasty is effective in significantly reducing perioperative blood loss and the number of allogeneic blood transfusion, without a corresponding increase in thromboembolic risk. It also improves the post- operative recovery without a significant drop in the post-operative haematological parameters such as haemoglobin and haematocrit. This supports the continued and potentially expanded use of tranexamic acid as a standard adjunct in perioperative blood management protocols for THA.

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