International Journal of Research in Orthopaedics
Surendrakumar PU et al. Int J Res Orthop. 2023 Mar;9(2):372-376
http://www.ijoro.org

DOI: https://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20230467

Original Research Article

Intraarticular use of tranexamic acid during primary total knee arthroplasty

Prathap Urumkar Surendrakumar*, Syed Abdul Hadi, Girish Marappa

Department of Orthopaedics, HOSMAT Hospital, Bengaluru, Karnataka, India

Received: 05 January 2023
Revised: 06 February 2023
Accepted: 10 February 2023

***Correspondence:**
Dr. Prathap Urumkar Surendrakumar,
E-mail: prathap.urumkar@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: Tranexamic acid (TXA) is effective in reduction of blood loss after major surgical procedures. In TKA surgeries, it is commonly administered intravenously. Since there are contraindications of systemic use of TXA, local/intraarticular TXA can also be used. The efficacy of both systemic and local TXA administration is demonstrated in the literature. The aim was to assess the effect of intraarticular TXA during total knee arthroplasty in terms of total blood loss and transfusion rate.
Methods: A total of 50 TKA in 34 patients were included in this prospective study. Patients received one dose of intraarticular TXA of 3 g after skin closure and before deflation of the tourniquet.
Results: The mean total blood loss in intra-articular TXA was 456.9 ml. None of the patients required transfusion postoperatively including those who underwent bilateral staged TKR. Mean postoperative hemoglobin loss was 1.07.
Conclusions: TXA reduced blood loss and transfusion requirement. Intra-articular administration of TXA seems to be more effective in terms of reducing total blood loss and transfusion rates. We recommend administration of topical TXA in primary TKA in healthy patients to decrease perioperative blood loss.

Keywords: Tranexamic acid, Intraarticular, Total knee arthroplasty

INTRODUCTION

Total knee replacement (TKR) has become one of the most common operations in orthopaedic practice.[1] With an increased life expectancy and a large incidence of osteoarthritis (OA) in older people, the demand for TKR as ultimate treatment option for advanced knee OA is also on the rise.[2] Blood loss is a common and challenging complication in total knee arthroplasty (TKA), which has been reported as ranging from 700 ml to 1700 ml.[3,4] The major causes of postoperative blood loss following TKA can be attributed to surgical trauma that induces a considerable activation of both the coagulation cascade and the local fibrinolysis.[5] Due to haemorrhage up to one third receive blood transfusions which are associated with additional risks and costs.[1,2] Allogeneic blood transfusion may be associated with other non-infectious complications, such as haemolysis, immunosuppression, transfusion-related acute lung injury and even death.[6] Hence the blood loss during TKA has to be prevented. Multiple strategies have been proposed to reduce blood loss following TKA, which can be divided into pre-, intra- and postoperative strategies.[7]

The safest and most effective method of reducing the requirement for blood transfusion is to minimise intra-operative bleeding by the use of a tourniquet, minimally invasive surgery, diathermy coagulation, sealing of the intramedullary femoral canal, the position of the knee and the use of antifibrinolytic agents.[8]

TXA is a synthetic anti-fibrinolytic agent that competitively inhibits the activation of plasminogen to plasmin, an enzyme that degrades fibrin clots, fibrinogen,

procoagulant factors V and VIII.[9] TXA can be administered intravenous, intraarticular or combined intravenous and intraarticular. It is generally accepted, however, that only a small percentage of intravenously injected TXA reaches the target location. The use of intravenous TXA in TKR has been a common practice. It can be given as a preoperative dose before tourniquet inflation, intraoperative dose before deflation of the tourniquet, postoperative dose three hours after surgery or various permutations combining these three doses. TXA, when given intravenously, has a wide distribution throughout the extracellular and intracellular compartments. Thus, a more efficient method (intra-articular injection) to deliver TXA is desirable.[10] It can be given as a topical wash or into the knee joint after wound closure via the drain. The benefits include ease of administration, ability to achieve maximum concentration at the bleeding site and minimal systemic absorption.

The main aim of this study was to assess the effect of intraarticular TXA during TKA.

METHODS

Type of study

It was a prospective observational study.

Duration of study

The study duration was from March 2022 to August 2022.

Source of data

The study was conducted on patients undergoing primary TKA in the department of orthopaedics, HOSMAT Hospital, Bangalore.

Sample size

The sample size for this study was 50.

The study was conducted after obtaining approval of Ethical committee members, HOSMAT hospital, Bangalore.

Method of collection of data

Patients with knee osteoarthritis who satisfy the inclusion criteria and exclusion criteria were included in the study. The patients will be evaluated clinically and functionally at the time of examination.

Inclusion criteria

Patients with unilateral or bilateral staged TKR, aged 55-70 years were included in the study.

Exclusion criteria

Patients with revision TKA surgeries; previous injuries or fractures around knee; prior surgery on the involved knee; simultaneous bilateral TKA; patient related-preoperative anemia requiring preop transfusion, H/O bleeding disorders or thromboembolic events were excluded.

Surgical technique

Anesthesia given was spinal+epidural.

Position of the patient during anesthesia was supine.

All patients received intravenous prophylactic antibiotics prior to surgery and two further doses post-operatively. A first-generation cephalosporin was used unless contraindicated.

Under tourniquet control, aseptic precaution patient parts were painted and draped. A standard midline skin incision with medial para-patellar approach was used. Tourniquet inflation continued for the remaining duration of the surgery until a compressive dressing was applied. Axial alignment was achieved with an extramedullary guide for the tibia and an intramedullary rod guide for the femur. Once bony cuts were made, standard soft tissue balancing was used to achieve sagittal and coronal balancing. All components were fixed with cement. The implants used were either the Stryker Traithlon CR or Depuy PS or Meril maxx PS. 3 gm TXA was injected into the knee after standard skin closure and drain was not used. Then the tourniquet was deflated after compression bandage.

Post-operatively all patients were given the same thrombo-prophylactic regimen. A low molecular weight heparin (LMWH) was given post-operatively and continued until discharge. Thereafter the LMWH was discontinued, and a low-dose aspirin (Ecosprin 75 mg) was given for a month at home.

Rehabilitation started on the first post-operative day with knee ROM and full weight bearing ambulation with walker for 2 weeks. Patients were discharged on day 5 for unilateral knee and day 11 for bilateral staged knee. Criteria were patient could mobilise independently to the bathroom and back, could climb stairs with assistance, could achieve knee flexion of at least 90 degrees, and pain was well controlled. Once discharged, patients were followed up after two weeks to assess the wound and range of movement. Further follow-up was at six weeks for assessment of mobility, range of movement and radiological evaluation.

The measurements indicating degree of blood loss included: pre-operative Hb levels, post-operative Hb levels on day 1 postoperatively. The blood volume was calculated with the formula described by Nader et al and Sehat et al.[15,16] It was based on the Hb decrease adjusted for the weight, height and sex of the patient.

Formula

Total blood loss (ml)=$\frac{100\times Hb_{loss}}{Hb_i}$,

$Hb_{loss}=BV\times(Hb_i-Hb_e)$,

BV (L)=estimated total body blood volume in litres,

=0.3669×H3+0.03219×W+0.6041 (men),

=0.3561×H3+0.03308×W+0.1833 (women),

where,

H is the patient's height (m), W is the body mass (kg), Hb_i is haemoglobin concentration prior to surgery (g/dl), and Hb_e is haemoglobin concentration post-operatively (g/dl).

Blood transfusion was done if one of the following criteria was met:

Hb <7-8 g/dl, in patients with preexisting cardiac disease,

Hb <6 g/dl, in patients without cardiac conditions,

presence of clinical symptoms of inadequate oxygen supply (dyspnea, tachypnea, reduced consciousness).

Statistical analysis

All the data were compiled in a tabulated manner. A statistical analysis software SPSS version 16.0 was used to analyse the data and calculate the frequency, mean, percentage and standard deviation as per requirement and nature of the data. Test of significance. For all calculations the confidence interval was set to 95% and p value <0.05 were considered significant.

RESULTS

Description of sample characteristics

Frequency and percentage distribution was computed to describe the sample characteristics of 34 patients (50 knees).

The average age of the patients was 64.2 years (Table 1).

The study group consisted of 34 patients (50 knees), of which 11 were males and 23 were females (Table 2).

Majority of the cases had undergone bilateral staged TKR (Table 3).

The mean Hb loss post operatively is 1.07 and SD is 0.41 with minimum loss of 0.5 and maximum of 2.4.

The mean total blood loss post operatively is 456.9 and SD is 165.1 with minimum loss of 211.9ml and maximum of 909.1 ml.

Table 1: Distribution of sample by age.

S. no.	Age group (in years)	Frequency	Percentage
1.	45-55	3	8.8
2.	56-65	15	44.1
3.	>65	16	47.1

Table 2: Distribution of sample by gender.

S. no.	Gender	Frequency	Percentage
1.	Male	11	32.3
2.	Female	23	67.7

Table 3: Distribution of sample by side of TKA.

S. no.	Side	Frequency	Percentage
1.	Right	9	26.4
2.	Left	9	26.4
3.	Bilateral	16	47.2

Table 4: Comparison of mean Hb pre op and post op.

Hb	Mean	SD
Pre op	11.76	1.22
Post op	10.64	1.09

Table 5: Amount of Hb loss.

Hb loss	Mean	SD
Post op	1.07	0.41

Table 6: Amount of total blood loss.

Total blood loss	Mean	SD
Post op	456.9	165.1

Table 7: Amount of mean total blood loss in male and female.

Total blood loss	Male	Female
Post op	498.3	439.2

Table 8: Post op blood transfusion.

TKR group	Transfusion
Unilateral	No
Bilateral	No

The mean total blood loss post operatively in men is 498.3 ml and in female is 439.2, which can be attributed to lower blood volume in females.

None of the patients who underwent unilateral or bilateral staged TKA required blood transfusion postoperatively.

DISCUSSION

This study aimed to assess the use of intraarticular TXA injection without the use of negative drainage on peri-operative blood loss following uncomplicated knee replacement. The study demonstrated that TXA was effective in reducing total blood loss, transfusion rate and without increasing the rate of complications.

There are five methods of TXA administration described in TKA to reduce blood loss which can be used either individually or in combination, namely: oral, topical, intravenous, intra-capsular and intra-articular.[3] Many studies focused on intravenous injections, although there were some concerns about thromboembolic complications. If administered in other routes only few percentages of TXA reached target location. Hence, we preferred intraarticular administration. Also it had low risk of systemic absorption and not contraindicated in systemic thrombosis.

Levine et al in a randomized controlled trial, had demonstrated, IV administration of TXA in TKA was safe and effective.[17] Iwai et al demonstrated that a double IV dose of TXA produced a further reduction of postoperative blood loss in TKA compared to a single administration, especially if the doses were given preoperatively and intraoperatively.[18] Similarly, Maniar et al also in a randomized controlled trial, demonstrated that a three-dose regimen (adding a postoperative dose) may be even more effective.[19] These studies confirmed the efficacy of different doses of IV TXA in reducing transfusion rates and total blood loss.

Intravenous TXA is contraindicated in patients with several comorbidities such as a history of thrombosis, myocardial infarction or severe renal dysfunction. Since patients undergoing TKA often suffer of severe comorbidities not all patients can be treated with prophylactic intravenous TXA. Hence, intraarticular application had been described.

Seo et al showed that local administration was superior to intravenous treatment.[20] Therefore, a local approach, minimizing systemic side effects whilst reducing the risk of postoperative bleeding, seemed preferable. This was consistent with the results of this study.

Different methods of intra-articular administration of TXA had also been described. Some authors injected the TXA once after completion of fascial closure to prevent leakage. Injecting the TXA percutaneously immediately after the skin had been closed had also been described.[21] Other studies described injecting TXA through the drain and clamping the drain for some period afterwards.[22] In this study, 3 gm TXA was administered percutaneously following skin closure without drain and before deflation of the tourniquet. It was postulated that the tamponade effect was lost with a drain, and this could lead to post-operative blood loss.[23] Hence, we did not use drain in our study. Wang et al also confirmed the efficacy of TKA without using drainage in terms of blood loss.[21]

A limitation to this study was there was no standardized method to measure blood loss. This study used the drop in hematocrit which could be affected by factors such as patient hydration. Another limitation of this study was our decision to consider blood volume as 5 liters. Hence approximate blood loss estimation may not be very accurate but definitely estimated total blood loss was less compared to other modes of TXA administration. Also, serum concentrations of TXA were not measured. Despite the potential limitations, the advantages of this study include the prospective nature of the study and measuring postoperative hemoglobin levels. The same surgical team operated all patients with the same technique.

CONCLUSION

This prospective study showed that intraarticular TXA during primary TKA significantly reduce postoperative blood loss and consequently reduced the need for blood transfusions without an increase in adverse events, especially thromboembolic events. Intra-articular dose of 3 g of TXA without drain given after skin closure and just before releasing tourniquet was more efficacious to reduce blood loss.

The intraarticular route may be attractive to surgeons caring for patients who are at increased risk of thromboembolic disease or in whom intravenous tranexamic acid is cautioned, e.g., renal impairment. As intraarticular administration of TXA in knee arthroplasty will continue to evolve, further studies with a larger sample size are required to figure out whether topical application is better than IV regimen.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Alshryda S, Sarda P, Sukeik M, Nargol A, Blenkinsopp J, Mason JM. Tranexamic acid in total knee replacement: a systemic review and meta-analysis. J Bone Joint Surg Br. 2011;93(12):1577-85.
2. Tille E, Mysliwietz J, Beyer F, Postler A, Lützner J. Intraarticular use of tranexamic acid reduces blood loss and transfusion rate after primary total knee arthroplasty. BMC Musculoskelet Disord. 2019;20:341.
3. Gericke E, DeBeer J, Deacon M, Marais LC. Percutaneous intra-articular tranexamic acid following total knee arthroplasty without drainage to reduce blood loss. SA Orthop J. 2020;19(2).
4. Marra F, Rosso F, Bruzzoni M, Edeoardo D, Bonasai, Dettoni F. Use of tranexamic acid in total knee arthroplasty. Joint. 2016;4(4):202-13.

5. Risberg B. The response of the fibrinolytic system in trauma. Acta Chir Scand. 1985;522:245-71.
6. Madjdpour C, Spahn DR. Allogeneic red blood cell transfusions: efficacy, risks, alternatives and indications. Br J Anaesth. 2005;95:33-42.
7. Harwin SF, Kapadia BH, Issa K, Mont MA. Blood management strategies in total knee arthroplasty. J Knee Surg. 2013;26(6):371-2.
8. Kalairajah Y, Simpson D, Cossey AJ, Verrall GM, Spriggins AJ. Blood loss after total knee replacement. Effects of computer-assisted surgery. J Bone Joint Surg. 2005;87:1480-2.
9. Chen JY, Chia S, Lo NN, Yeo SJ. Intra-articular versus intravenous tranexamic acid in primary total knee replacement. Ann Transl Med. 2015;3(3):33.
10. Digas G, Koutsogiannis I, Meletiadis G, Antonopoulou E, Karamoulas V, Bikos C. Intra-articular injection of tranexamic acid reduce blood loss in cemented total knee arthroplasty. Eur J Orthop Surg Traumatol. 2015;25(7):1181-8.
11. Antapur P, Gandhi R, Mahomed NN. Topical and intra-articular tranexamic acid in total knee arthroplasty. Orthogate. 2013.
12. Gomez-Barrena E, Ortega-Andreu M. Topical intra-articular compared with intravenous tranexamic Acid to reduce blood loss in primary total knee replacement: a double-blind, randomized, controlled, noninferiority clinical trial. J Bone Joint Surg Am. 2014;96:1937-44.
13. Huang Z, Ma J, Shen B. Combination of intravenous and topical application of tranexamic Acid in primary total knee arthroplasty: a prospective randomized controlled trial. J Arthroplasty. 2014;29:2342-6.
14. Eriksson, Olaspers S. Pharmacokinetics of tranexamic acid after intravenous administration to normal volunteers. Europ J Clin Pharmacol. 1974;7(5):375-80.
15. Nader SB, Hidalgo JU, Blouch T. Prediction of blood volume in normal human adults. Surgery. 1962;51:224-32.
16. Sehat KR, Evans RL, Newman JH. Hidden blood loss following hip and knee arthroplasty. Correct blood loss should take hidden loss into account. J Bone Joint Surg Br. 2004;86(4):561-5.
17. Levine BR, Haughom BD, Belkin MN. Weighted versus uniform dose of tranexamic acid in patients undergoing primary, elective knee arthroplasty: a prospective randomized controlled trial. J Arthroplasty. 2014;29(9):186-8.
18. Iwai T, Tsuji S, Tomita T. Repeat-dose intravenous tranexamic acid further decreases blood loss in total knee arthroplasty. Int Orthop. 2013;37:441-5.
19. Maniar R, Kumar G, Singhi T. Most effective regimen of tranexamic acid in knee arthroplasty: a prospective randomized controlled study in 240 patients. Clin Orthop Relat Res. 2012;470:2605-12.
20. Seo JG, Moon YW, Park SH, Kim SM, Ko KR. The comparative efficacies of intra-articular and IV tranexamic acid for reducing blood loss during total knee arthroplasty. Knee Surg Sports Traumatol Arthrosc. 2013;21(8):1869-74.
21. Wang CG, Sun ZH, Liu J, Cao JG, Li ZJ. Safety and efficacy of intra-articular tranexamic acid injection without drainage on blood loss in total knee arthroplasty: A randomized clinical trial. Int J Surg. 2015;20:1-7.
22. Ishida K, Tsumura N, Kitagawa A. Intra-articular injection of tranexamic acid reduces not only blood loss but also knee joint swelling after total knee arthroplasty. Int Orthop. 2011;35(11):1639-45.
23. Goes RFA, Silva AF, Lyra FS. Prospective randomized study after the use of drains in total knee arthroplasty with implant. Rev Bras Ortop. 2013;48(3):257-62.

Cite this article as: Surendrakumar PU, Hadi SA, Marappa G. Intraarticular use of tranexamic acid during primary total knee arthroplasty. Int J Res Orthop 2023;9:372-6.