Journal of Shoulder and Elbow Arthroplasty
Volume 3: 1–5

DOI: 10.1177/2471549218821181
journals.sagepub.com/home/sea
SAGE

Topical and Intravenous Tranexamic Acid Are Equivalent in Decreasing Blood Loss in Total Shoulder Arthroplasty

Matthew Budge, MD[1]

Abstract

Introduction: Tranexamic acid (TXA) has been shown to be an effective modality to decrease blood loss in total shoulder arthroplasty (TSA). However, the most effective method of TXA administration remains controversial. The purpose of this study was to directly compare the use intravenous and topical TXA to determine which regimen was more effective in improving postoperative hemoglobin (Hb), transfusion rates, and patient outcomes after primary TSA.

Methods: We conducted a retrospective review of 3 sequential cohorts of patients undergoing primary TSA with no TXA, intravenous TXA, or topical TXA. Postoperative data collection included daily Hb levels (g/dL), transfusions, thromboembolic events, length of stay, and discharge disposition. One-way analysis of variance was used to compare data between the 3 groups with post hoc Tukey honestly significant difference test for differences between pairs.

Results: Average change in Hb was 2.36 g/dL in the IV TXA group and 2.27 g/dL in the Topical TXA group which was not statistically significant ($P = .69$). Average change in Hb in the control group was 3.27 g/dL which was significant when compared to both TXA groups ($P < .01$). There were no transfusions or thromboembolic events in either TXA group. In the control group, there were 2 transfusions which was not statistically significant ($P = .09$). There was no significant difference in the discharge disposition or days in hospital between the 2 groups receiving TXA ($P = .33$).

Conclusion: Intravenous and topical TXA are equivalent in improving postoperative Hb in TSA.

Keywords

shoulder, replacement, outcomes, osteoarthritis, arthroplasty, tranexamic acid, blood loss

Date received: 22 March 2018; accepted: 3 December 2018

Introduction

In the total hip and knee arthroplasty literature, the use of both topical and intravenous (IV) tranexamic acid (TXA) has been proven to be effective for reducing perioperative blood loss, decreasing transfusion rates, and improving patient outcomes.[1–8] More recent studies specific to total shoulder arthroplasty (TSA) have shown the effectiveness of both topical and IV TXA in reducing postoperative blood loss, increasing postoperative hemoglobin (Hb) levels, and decreasing length of stay.[9,10] However, there are a wide variety of TXA dosing protocols described in the orthopedic literature, including weight-based dosing, non-weight-based dosing, single-dose IV, single-dose topical, and multiple dose IV.[1–8]

With the current diversity of TXA treatment protocols, there is currently no consensus on the ideal method of TXA dosing to minimize perioperative blood loss while avoiding complications which may be associated with its use. IV administration of TXA is advantageous due to its ease of use and intraoperative coverage during TSA, but carries a theoretical risk of increased thrombosis, anaphylaxis, and renal failure.[11,12] Topical administration, on the other hand, is considered to be safer for patients with an elevated risk of thrombosis or renal failure. However, it is time consuming to use, and as it is applied at the end of the case, it may not have an effect on intraoperative blood loss.

[1]Kaiser-Permanente Northwest, Salem, Oregon

Corresponding Author:
Matthew Budge, Kaiser-Permanente Northwest, 5125 Skyline Road S, Salem, OR 97306, USA.
Email: mdbudge@hotmail.com

The lack of consensus on an optimal dosing regimen for TXA indicates that additional scientific study is needed to find the best mix of efficacy and decreased risk for patients undergoing TSA. The purpose of this study was to compare the use of IV and topical TXA in TSA to determine which regimen was most effective in improving postoperative Hb, transfusion rates, and patient outcomes. We hypothesized that IV and topical TXA cohorts would have similar improvements in postoperative Hb, transfusion requirements, and length of hospital stay, and that these results would be superior to patients who did not receive TXA.

Material and Methods

We conducted a retrospective review during a 4-year period of 3 cohorts of patients undergoing primary reverse or anatomic TSA. All procedures were performed by 2 shoulder and elbow and 1 sports medicine fellowship trained orthopedic surgeon with experience in TSA. Revision procedures, fracture procedures, and patients on preoperative anticoagulants were excluded to avoid confounding variables. Both anatomic and reverse total shoulders were included. The use of a drain and/or cement fixation was under the discretion of the operating surgeon; however, drain output was not recorded. All patients received either a single-shot supraclavicular nerve block or supraclavicular nerve block with an indwelling catheter for postoperative pain control.

From 2011 to 2013, all patients undergoing primary anatomic or reverse TSA did not receive TXA in any form and served as the control group (n = 24). From 2013 to 2015, patients received 1000 mg of TXA intravenously prior to the incision and then again once implants were placed and served as our first cohort (n = 28). From 2015 to 2016, patients received 3000 mg of TXA diluted in 100 cm^3 of normal saline topically after the implants were placed and served as second cohort (n = 28).[8] The topical TXA was allowed to stand in joint for 5 min and was applied after final irrigation.

In the postoperative period, patients receiving no TXA or IV TXA were treated with early mobilization and sequential compression devices (SCD) for thromboprophylaxis. Patients receiving topical TXA received either SCD's (n = 15) or SCD's and Aspirin 325 mg by mouth twice daily for 14 days (n = 13) for thromboprophylaxis which was at the discretion of the surgeon.

Postoperative treatment protocols were at the discretion of the operating surgeon but in general included sling and abduction pillow for 4 weeks and early physical therapy and mobilization within selected motion parameters.

Postoperative data collection included Hb (g/dL) in the AM of each day in hospital, need for transfusion, length of stay, wound complications, discharge to nursing facility or home, and any positive study for a thromboembolic event.

Statistical analysis was performed using Excel (Microsoft Corporation). One-way analysis of variance was used to compare the quantitative data between the 3 groups with post hoc Tukey honestly significant difference test for differences between pairs. A P value of $<.05$ was considered statistically significant. Post hoc power analysis showed a 7% power to detect a 5% difference in transfusion rates with an alpha of .05.

Results

There were no significant preoperative differences between the 3 groups of patients including: age, sex, American Society of Anesthesiologists classification, body mass index, drain usage, or procedure type (Table 1).

There were 28 patients in each of the TXA groups and 24 in the control group. Average change in Hb was 2.36 g/dL in the IV TXA group and 2.27 g/dL in the Topical TXA group which was not statistically significant ($P = .69$). Average change in Hb in the control group was 3.27 g/dL which was significant when compared to both TXA groups ($P < .01$) (Table 2). There were no transfusions or thromboembolic events in either TXA group. In the control group, there were 2 transfusions which was not statistically significant ($P = .09$) (Table 3). There was no wound complications recorded in any group. There was no significant difference in the discharge disposition or days in hospital between the TXA groups ($P = .34$) (Table 4). There was a significant difference between days in hospital between the topical TXA group (Ave = 1.6 days) and the control group

Table 1. Demographics.

	Topical TXA	IV TXA	No TXA	*P*
Number of patients	28	28	24	
Age years (mean)	68	69	71	.51
Gender				.84
Male	15	14	12	
Female	13	14	12	
Procedure				.15
TSA	15	17	19	
RTSA	13	11	5	
Drain (yes/no)	5/28	4/28	6/24	.41
ASA (mean)	2.5	2.6	2.6	.70
BMI (mean)	34	32	33	.77

Abbreviations: ASA, American society of Anesthesiologists; BMI, body mass index; IV, intravenous; RTSA, reverse total shoulder arthroplasty; TSA, total shoulder arthroplasty; TXA, tranexamic acid.

Table 2. Clinical Outcomes Between Paired Cohorts.

	Change in Hb		Transfusion	
	Mean (g/dL)	*P*	Number	*P*
Topical vs IV TXA	2.15 vs 2.36	.69	0 vs 0	NA
Topical vs No TXA	2.15 vs 3.27	.01	0 vs 2	.13
IV TXA vs No TXA	2.36 vs 3.27	.01	0 vs 2	.13

Abbreviations: Hb, hemoglobin; IV, intravenous; NA, not applicable; TXA, tranexamic acid.

Table 3. Outcomes Between All Cohorts.

	Topical TXA	IV TXA	Control	*P*
Hb change (g/dL) [mean]	2.15	2.36	3.27	.01
Transfusion (number)	0	0	2	.09
Length of stay (days) [mean]	1.6	2.0	2.3	.03
Discharge status (number)				.85
Home	26	25	22	
SNF	2	3	2	

Abbreviations: Hb, hemoglobin; IV, intravenous; SNF, skilled nursing facility; TXA, tranexamic acid.

Table 4. Discharge Outcomes Between Paired Cohorts.

	Days in Hospital		Discharge to SNF	
	Number (Days)	*P*	Number	*P*
Topical vs IV TXA	1.6 vs 2.0	.34	2 vs 3	.85
Topical vs No TXA	1.6 vs 2.3	.04	2 vs 2	.93
IV TXA vs No TXA	2.0 vs 2.3	.50	3 vs 2	.93

Abbreviations: Hb, hemoglobin; IV, intravenous; SNF, skilled nursing facility; TXA, tranexamic acid.

(Ave = 2.3 days) which was not seen in the IV TXA group ($P = .04$) (Table 4).

Discussion

TSA has proven to be an effective procedure for relieving pain and increasing function in patients with significant shoulder pathology.[13–16] However, even in experienced hands, TSA can be associated with significant blood loss and transfusion requirements with reported transfusion rates between 6.7% and 43%.[17–22] Recent studies in total knee and hip arthroplasty have shown that the use of both topical and IV TXA leads to marked improvements in postoperative blood loss and transfusion requirements.[1–8] Comparative studies in the total joint literature have also shown equivalent results for topical and IV TXA in terms of blood loss and reduction in transfusion rates.[23,24]

In the shoulder arthroplasty literature, there have been several recent studies showing the efficacy of TXA, in both IV and topical forms, in preventing postoperative blood loss.[9,10,25,26] Both Abildgaard et al. and Gillespie et al. showed similar results to our study in terms of postoperative change in Hb with an improvement in the TXA group of around 1 g/dL compared to controls.[10,25] Vara et al. in a recent randomized controlled trial showed less drain output and less total Hb loss compared to controls.[26] However, no shoulder arthroplasty study to date has shown a statistically significant decrease in the transfusion rate using TXA in either form.

There are currently no comparative studies in the shoulder arthroplasty literature to determine which method of administration is more effective for decreasing blood loss and improving patient outcomes. The question of IV versus topical administration of TXA is important for several reasons. Benefits of topical administration include no theoretical increased risk thromboembolic events and the ability to use TXA in patients on anticoagulants.[11,12] However, the actual risk of thromboembolic events with the use of TXA is unknown, and recent studies have shown no significant increase in these events with TXA use in hip and knee arthroplasty or in shoulder arthroplasty.[27,28] Disadvantages to the topical administration of TXA include that the hemostatic benefits of TXA are not realized during the procedure itself and that operative time may be increased while allowing TXA to bathe the incision.

In this study, we evaluated the efficacy of both IV and topical TXA to prevent postoperative blood loss during TSA, as measured by postoperative Hb levels and transfusion rates. We found that both methods equally improved postoperative Hb by 1 g/dL when compared to a no TXA control group. There was a trend toward decreased transfusion rates with TXA use of both types, but this was not statistically significant. Similarly, this study was not adequately powered to determine a significant difference in transfusion rates or thromboembolic events between the groups.

We did not find a decreased length of stay or increased frequency of discharge to home versus skilled nursing facility when comparing IV to topical TXA. However, when compared to the control group, the topical TXA group did have a significant improvement in days in hospital indicating that there is perhaps some benefit in terms of clinical outcome with the use of TXA. However, given the multifactorial nature of discharge planning for patients, this would be difficult to say with confidence with this relatively small cohort of patients.

This study has some limitations in addition to the standard ones imposed by a retrospective study design. There were multiple surgeons in each study group which

may have introduced confounding factors that were not evaluated in this study. In addition, there was no attempt to quantify intraoperative blood loss other than measurement of postoperative Hb and transfusion rate. Separate measurements of intra and postoperative blood loss may have shown a difference between the treatment groups. Also, there was a difference in postoperative anticoagulation between the topical TXA group and the IV TXA group which could have influenced the results. However, mean change in postoperative Hb in the topical TXA group was actually less than the IV group, indicating that this had minimal if any effect on postoperative Hb measurements in the first several days after surgery.

Conclusion

This study demonstrates that both IV and topical administration of TXA are equally effective for improving postoperative Hb levels when used during TSA. In addition, there was a trend toward decreased transfusion rate and number of days in hospital with both TXA cohorts compared to control indicating that further large scale, prospective studies are warranted.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

References

1. Alshryda S, Sukeik M, Sarda P, Blenkinsopp J, Haddad FS, Mason JM. A systemic review and meta-analysis of the topical administration of tranexamic acid in total hip and knee replacement. *Bone Joint J*. 2014;96-B:1005–1015.
2. Chang CH, Chang Y, Chen DW, Ueng SW, Lee MS. Topical tranexamic acid reduced blood loss and transfusion rates associated with primary total hip arthroplasty. *Clin Orthop Relat Res*. 2014;472:1552–1557.
3. Gilbody J, Dhotar HS, Perruccio AV, Davey JR. Topical tranexamic acid reduces transfusion rates in total hip and knee arthroplasty. *J Arthroplasty*. 2013;28:78–82.
4. Imai N, Dohmae Y, Suda K, Miyasaka D, Ito T, Endo N. Tranexamic acid for reduction of blood loss during total hip arthroplasty. *J Arthroplasty*. 2012;27:1838–1843.
5. Keyhani S, Esmailiejah A, Abbasian M, Safdari F. Which route of tranexamic acid administration is more effective to reduce blood loss following total knee arthroplasty? *Arch Bone Jt Surg*. 2016;4(1):65–69.
6. Patel JN, Spanyer JM, Smith LS, Huang J, Yakkanti MR, Malkani AL. Comparison of intravenous versus topical tranexamic acid in total knee arthroplasty: a prospective randomized study. *J Arthroplasty*. 2014;29:1528–1531.
7. Yang ZG, Chen WP, Wu LD. Effectiveness and safety of tranexamic acid in reduction blood loss in total knee arthroplasty: a meta-analysis. *J Bone Joint Surg Am*. 2012;94:1153–1159.
8. Yue C, Kang P, Yang P, Xie J, Pei F. Topical application of tranexamic acid in primary total hip arthroplasty: a randomized double-blind controlled trial. *J Arthroplasty*. 2014;29:2452–2456.
9. Friedman RJ, Gordon E, Butler B, Mock L, Dumas B. Tranexamic acid decreases blood loss after total shoulder arthroplasty. *J Shoulder Elbow Surg*. 2016;25(4):614–618.
10. Gillespie R, Shishani Y, Joseph S, Streit J, Gobezie R. A randomized, prospective evaluation on the effectiveness of tranexamic acid in reducing blood loss after total shoulder arthroplasty. *J Shoulder Elbow Surg*. 2015;24:1679–1684.
11. Dunn CJ, Goa KL. Tranexamic acid a review of its use in surgery and other indications. *Drugs*. 1999;57:1005–1032.
12. Eubanks JD. Antifibrinolytics in major orthopaedic surgery. *J Am Acad Orthop Surg*. 2010;18:132–138.
13. Cuff D, Pupell D, Virani N, Levy J, Frankle M. Reverse shoulder arthroplasty for the treatment of rotator cuff deficiency. *J Bone Joint Surg Am*. 2008;90(6):1244–1251.
14. Deshmukh A, Koris M, Zurakowski D, Thornhill TS. Total shoulder arthroplasty: long-term survivorship, functional outcome, and quality of life. *J Shoulder Elbow Surg*. 2005;14:471–479.
15. Raiss P, Bruckner T, Rickert M, Walch G. Longitudinal observational study of total shoulder replacements with cement. *J Bone Joint Surg Am*. 2014;96:198–205.
16. Sperling JW, Cofield RH, Rowland CM. Minimum fifteen-year follow-up of Neer hemiarthroplasty and total shoulder arthroplasty in patients aged fifty years or younger. *J Shoulder Elbow Surg*. 2004;13:604–613.
17. Ahmadi S, Lawrence TM, Sahota S, et al. The incidence and risk factors for blood transfusion in revision shoulder arthroplasty: our institution's experience and review of the literature. *J Shoulder Elbow Surg*. 2014;23:43–48.
18. Anthony CA, Westermann RW, Gao Y, Pugely AJ, Wolf BR, Hettrich CM. What are risk factors for 30-day morbidity and transfusion in total shoulder arthroplasty. *Clin Orthop Relat Res*. 2015;473:2099–2105.
19. Gruson KI, Accousti KJ, Parsons BO, Pillai G, Flatow EL. Transfusion after shoulder arthroplasty: an analysis of rates and risk factors. *J Shoulder Elbow Surg*. 2009;18:225–230.
20. Hardy JC, Hung M, Snow BJ, et al. Blood transfusion associated with shoulder arthroplasty. *J Shoulder Elbow Surg*. 2013;22:233–239.
21. Ryan DJ, Yoshihara H, Yoneoka D, Zuckerman JD. Blood transfuxion in primary total shoulder arthroplasty: incidence, trends, and risk factors in the United States from 2000 to 2009. *J Shoulder Elbow Surg*. 2015;24:760–765.
22. Sperling JW, Duncan SF, Cofield RH, Schleck C, Harmsen WS. Incidence and risk factors for blood transfusion in shoulder arthroplasty. *J Shoulder Elbow Surg*. 2005;14:599–601.

23. Abdel MP, Chalmers BP, Taunton MJ, et al. Intravenous versus topical tranexamic acid in total knee arthroplasty: both effective in a randomized clinical trial of 640 patients. *J Bone Joint Surg Am*. 2018;100(12):1023–1029.
24. Gomez-Barrena E, Ortega-Andreu M, Padilla-Eguiluz NG, Pérez-Chrzanowska H, Figueredo-Zalve R. 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(23):1937–1944.
25. Abildgaard JT, McLemore R, Hattrup SJ. Tranexamic acid decreases blood loss in total shoulder arthroplasty and reverse total shoulder arthroplasty. *J Shoulder Elbow Surg*. 2016;25:1643–1648.
26. Vara AD, Koueiter MD, Pinkas DE, Gowda A, Wiater BP, Wiater JM. Intravenous tranexamic acid reduces total blood loss in reverse total shoulder arthroplasty: a prospective, double-blinded, randomized controlled trial. *J Shoulder Elbow Surg*. 2017;26(8):1383–1389.
27. Duncan CM, Gillette BP, Jacob AK, Sierra RJ, Sanchez-Sotelo J, Smith HM. Venous thromboembolism and mortality associated with tranexamic acid use during total hip and knee arthroplasty. *J Arthroplasty*. 2015;30(2):272–276.
28. Hallstrom B, Singal B, Cowen ME, Roberts KC, Hughes RE. The Michigan experience with safety and effectiveness of tranexamic acid use in hip and knee arthroplasty. *J Bone Joint Surg Am*. 2016;98(19):1646–1655.