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Tranexamic acid decreases blood loss in total shoulder arthroplasty and reverse total shoulder arthroplasty

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Background: Efficacy of tranexamic acid (TXA) remains unproven in the setting of shoulder arthroplasty. The purpose of this study was to determine the effects of TXA on perioperative blood loss and drain output in patients undergoing primary total shoulder arthroplasty (TSA) and reverse total shoulder arthroplasty (RTSA).
Methods: We conducted a retrospective comparison of 77 TSAs and 94 RTSAs performed in 168 patients. TXA was administered intravenously in 35 TSA and 42 RTSA patients. Changes in hemoglobin (Hgb), hematocrit (Hct), drain output, and total blood loss were reviewed with univariate analysis and additional multivariate regression examining the cofactors of age, body mass index, American Society of Anesthesiologists status, and gender of each patient.
Results: Use of TXA in TSA led to a significant decrease in total blood loss (679 mL vs. 910 mL; $P < .001$), change in Hgb (1.8 mg/dL vs. 2.6 mg/dL; $P < .001$), and drop in Hct (5.2 vs. 7.0; $P < .001$). Similarly, RTSA also had significantly less total blood loss with the use of TXA (791 mL vs. 959 mL; $P < .001$), change in Hgb (2.3 mg/dL vs. 2.9 mg/dL; $P < .001$), and change in Hct (6.4 vs. 8.3; $P < .001$). TXA also significantly decreased drain output in both TSA (99 mL vs. 235 mL; $P < .001$) and RTSA (180 mL vs. 370 mL; $P < .001$).
Conclusions: Use of TXA perioperatively among patients undergoing primary shoulder arthroplasty can decrease perioperative blood loss, change in Hgb and Hct, and postoperative drain output.
Level of evidence: Level III; Retrospective Cohort Design; Treatment Study

Keywords: Shoulder arthroplasty; reverse shoulder arthroplasty; blood loss; tranexamic acid; drain output; hemoglobin; hematocrit

The impact of blood loss in shoulder arthroplasty has been well studied in the orthopedic literature.[12,13,19,23] Complications related to blood loss range from postoperative hematoma to requirement for transfusion.[5,11,14] Overall rates of blood transfusion after total shoulder arthroplasty (TSA) have been reported to range from 7.4% to 43%.[12-14] Reverse total

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shoulder arthroplasty (RTSA) has been identified as an additional risk factor for a need for transfusion.[12,14] In addition, patients undergoing RTSA have been shown to have an elevated risk of postoperative hematoma, with the reported incidence ranging from 1% to 20% in recent literature.[4,7,29]

Tranexamic acid (TXA) is an antifibrinolytic agent that competitively inhibits the activation of plasminogen to plasmin, thereby decreasing the degradation of fibrin. TXA has been used to reduce perioperative blood loss, postoperative drain output, and subsequent need for blood transfusions in both total hip arthroplasty (THA) and total knee arthroplasty (TKA) while demonstrating no increased risk for venous thromboembolism (VTE).[1,10,15,17,18,25,30]

To date, no peer-reviewed literature exists on the use of intravenous TXA for decreasing blood loss in shoulder arthroplasty. The purpose of this study was to determine the efficacy of TXA with regard to blood loss in the setting of TSA and RTSA. We hypothesized that TXA use would decrease total blood loss and postoperative drain output and be reflected in a decreased postoperative change in hemoglobin (Hgb) and hematocrit (Hct). In addition, we sought to identify whether demographic factors such as age, gender, body mass index (BMI), and American Society of Anesthesiologists (ASA) status affect perioperative blood loss and drain output in association with the use of TXA.

Methods

This study performed a retrospective analysis on a cohort of 168 patients who underwent 171 procedures by a single surgeon (S.J.H.). Surgical intervention consisted of either TSA or RTSA. Analysis was prompted by a change in practice, occurring in 2014, that led to prescribed TXA for all patients in an effort to reduce blood loss and postoperative drain output. Before this point, TXA was not used, and these patients served as a comparison group. Intravenous TXA was used in all patients, except those with documented history of venous thromboembolic event, allergy to TXA, thrombophilia, or high risk of VTE as based on the guidelines of the American Academy of Orthopaedic Surgeons for use of intravenous TXA.

Clinical records were reviewed for 168 patients who underwent surgery from August 2013 through March 2015. Before study initiation, a power analysis was performed using pilot data to obtain a statistical power of 0.85 and α error of .05. During data collection, the following points were obtained: age, gender, BMI, height, weight, diagnosis, surgery performed, ASA status, preoperative Hgb and Hct, postoperative Hgb and Hct, surgical drain output, and requirement for blood transfusion. Patients 50 years or older who underwent primary TSA and RTSA were eligible for study inclusion. We excluded patients younger than 50 years (5 shoulders), procedures related to an oncologic diagnosis (1 shoulder), and patients with incomplete preoperative or postoperative laboratory data (2 shoulders). One patient underwent staged TSAs for bilateral osteoarthritis; preoperative laboratory tests were not repeated before the second procedure, which was therefore excluded. Postoperative laboratory tests were simply not obtained for the second patient, leading to exclusion. In total, 6 patients and 7 procedures were excluded from the final analysis.

All surgeries were performed by the senior author (S.J.H.). After anesthetic induction, 1 g of TXA was administered intravenously in all patients. As the half-life of TXA is 2 hours,[22] repeating the dosing of TXA was not considered necessary, given the typical surgical time of approximately 1 hour. All patients received general anesthesia with a preoperative scalene block placed by the anesthesiologist. Surgery used a deltopectoral incision, and meticulous electrocautery of soft tissue bleeding was performed after initial dissection to the level of the deltopectoral fascia and additionally as needed throughout the procedure. A subscapularis tenotomy was performed for intra-articular access and repaired at the conclusion of the case for all TSA procedures and RTSA cases with an intact muscle-tendon unit. All procedures were unilateral and used the same prosthesis for TSA (Bigliani/Flatow Anatomical Total Shoulder; Zimmer, Warsaw, IN, USA) and RTSA (Trabecular Metal Inverse/Reverse Total Shoulder, Zimmer). A single Hemovac drain was placed at the end of the procedure and maintained in place until 0600 on postoperative day 1. This time period was chosen to accommodate the institution's standard nursing workflows and documentation policies. No changes to surgical technique or protocol were made during the study period. Chemical deep venous thrombosis (DVT) prophylaxis was not routinely used postoperatively. Patients with a preexisting medical condition that required chronic anticoagulation therapy resumed their home dosage perioperatively. Patients receiving chronic warfarin were restarted on their home dose the evening of surgery at 2100. Aspirin and clopidogrel were restarted on postoperative day 1, and enoxaparin was restarted on postoperative day 2 when it was used as a bridging medication. Postoperative Hgb and Hct levels were obtained on postoperative day 1 and any remaining day the patients remained in the hospital. Total Hgb and Hct loss was calculated by subtracting the Hgb and Hct levels on the first postoperative day from the preoperative values. Drain output was recorded by nursing staff and entered into the electronic medical record. Total blood loss was calculated by the formula reported by Nadler et al[20] and Good et al[10] using the maximum postoperative decrease in the Hgb level, adjusted for the height and weight of the patient.

Final statistical analysis included 168 patients who underwent 171 shoulder arthroplasties. Thirty-five TSAs were performed with the use of TXA and 42 without. Forty-two RTSA patients received TXA and 52 did not. Average age of the patients was 70 years (53-87 years) for TSA and 71.1 years (53-90 years) among the RTSA cohort. There was no statistically significant difference in patient baseline demographics, including age, gender, BMI, ASA status, preoperative Hgb, and preoperative Hct as analyzed by Student *t*-test continuous data and χ^2 categorical data (Table I). Of the TSA patients, 1 case was performed for the indication of osteonecrosis; the remaining 76 were performed for osteoarthritis. Forty-five patients underwent RTSA for rotator cuff arthropathy; the remaining indications were massive rotator cuff tear (34), osteoarthritis with insufficient cuff (8), osteoarthritis with significant posterior glenoid erosion (3), 3- or 4-part proximal humerus fracture (2), osteonecrosis with insufficient cuff (1), and rheumatoid arthritis with insufficient cuff (1). We examined the effect of TXA use on blood loss, change in Hgb, change in Hct, and drain output. Type of arthroplasty was used as a variable in the model. Student *t*-test and regression were used to analyze all 4 outcomes. Model fit was assessed through the construction of normal quantile-quantile (QQ) plots as well as consultation of standard regression diagnostics (Cook's distance, influential observations).