J Shoulder Elbow Surg (2016) 25, 614-618

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Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

Tranexamic acid decreases blood loss after total shoulder arthroplasty

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Background: Tranexamic acid (TXA) significantly decreases blood loss and transfusion rates after total hip and total knee arthroplasty. The purpose of this study was to determine the effects of intravenous TXA on blood loss and patient outcomes after total shoulder arthroplasty (TSA).
Methods: TXA was used in 106 consecutive patients undergoing primary anatomic and reverse TSA with a dose of 20 mg/kg intravenously (TXA group) and compared with the previous consecutive 88 patients without TXA (non-TXA group). All patients had a blood sample drawn for a hemoglobin and hematocrit determination the morning after surgery. Analysis of variance and χ^2 techniques were used to analyze study hypotheses.
Results: Statistically significant differences in both hemoglobin loss (TXA group $\Delta = 2.13$ vs. non-TXA group $\Delta = 2.63$; $P = .01$) and hematocrit loss (TXA group $\Delta = 6.4$ vs. non-TXA group $\Delta = 8.14$; $P < .01$) were seen in the TXA group compared with the non-TXA group. In patients receiving TXA, there were statistically significant decreases in the time spent in the recovery room (mean, TXA group 69 minutes vs. non-TXA group 87 minutes; $P < .02$) and total length of hospitalization (mean, TXA group 1.18 days vs. non-TXA group 1.4 days; $P = .01$). Two patients in the TXA group received a blood transfusion, whereas 6 patients in the non-TXA group did.
Conclusions: TXA 20 mg/kg intravenously given just before primary anatomic and reverse TSA results in statistically significant reductions in blood loss. Patients spent 21% less time in the recovery room and had a 16% shorter hospitalization, resulting in financial savings for the hospital.
Level of evidence: Level III, Retrospective Cohort Design, Treatment Study.

Keywords: Tranexamic acid; total shoulder arthroplasty; blood loss; patient outcomes; anatomic shoulder arthroplasty; reverse shoulder arthroplasty; blood transfusion

An estimated 66,485 total shoulder arthroplasties (TSAs) were performed in 2011, representing a steadily increasing incidence and demand during the last decade.[26] TSA is a major orthopedic procedure, conferring significant potential blood loss and complications. Multiple established perioperative modalities are used with variable results to reduce perioperative bleeding and transfusion requirements during TSA, including controlled permissive hypotension, hemodilution, autologous donations and blood conservation protocol, and recent trends toward chemoprophylactic clot degradation augmentation using antifibrinolytics.[4-8,10,11,14,30,31,34,36]

The Institutional Review Board of Roper Hospital approved this research.

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1058-2746/$ - see front matter © 2016 Journal of Shoulder and Elbow Surgery Board of Trustees.
http://dx.doi.org/10.1016/j.jse.2015.09.014

With positive results in total hip arthroplasty (THA) and total knee arthroplasty (TKA), spine surgery, and cardiac surgery, fibrinolysis and its inhibition have more recently been extensively reviewed.[9,12,24,28,35,38] Fibrinolytic inhibition aims to reduce the amount of operative and postoperative blood loss by preventing breakdown of formed clot. One such mode of fibrinolytic inhibition is with tranexamic acid (TXA), which acts by competitively inhibiting fibrinolysis.[14] TXA is a synthetic analogue of the amino acid lysine that functions by blocking formed clot degradation through the reversible occupation of plasminogen and plasmin lysine binding sites. Plasminogen, plasmin's zymogen, and its active protease plasmin bind to fibrin through the lysine binding site, ultimately resulting in fibrin clot degradation. By occupying lysine binding sites, TXA competitively inhibits plasminogen's or plasmin's binding ability to fibrin and resultant degradation.[3,9,12,22] TXA's antifibrinolytic properties result in less perioperative blood loss, fewer wound hematomas, and significantly lower transfusion rates as demonstrated by multiple systematic reviews and meta-analyses.[9,14,15,17,21,27,35]

Multiple studies in THA and TKA have investigated TXA's efficacy and safety, demonstrating significant clinical improvements in reducing blood loss and wound hematomas, decreasing blood transfusion rates, and shortening operative times. TXA has demonstrated an excellent safety profile with minimal side effects and no increase in thromboembolic or cardiac events in the perioperative period, all while being cost-effective.[18,24,25,33,38,39] Recently, topical wound application of TXA was shown to significantly decrease blood loss after primary TSA.[19] Although venous thromboembolism was a concern initially, multiple studies have investigated the use of perioperative TXA and never shown an increased risk of venous thromboembolism.[1-3,20,23,28,29,32,37]

Despite TXA's current widespread use in total joint arthroplasty, adult spine surgery, and scoliosis surgery, a thorough review of the English literature has not revealed any studies investigating its efficacy and safety in primary TSA when it is given intravenously. The purpose of this study, therefore, was to determine the effects of intravenously administered TXA on blood loss and patient outcomes after primary TSA. Our hypothesis was that the use of a single intravenous preoperative TXA dose would reduce perioperative blood loss, transfusion requirements, and length of hospitalization in patients undergoing primary TSA.

Materials and methods

We conducted a retrospective review of 2 patient cohorts during a 6-year period undergoing primary TSA at a single center by a senior orthopedic surgeon (R.J.F.) with extensive experience in TSA. Revisions were not included to avoid confounding variables such as increased blood loss and longer operative times. All reverse total shoulder humeral components were cemented, and more than 90% of anatomic humeral components were press fit.

Beginning in August 2009, all patients undergoing primary TSA, including 54 anatomic TSAs and 52 reverse TSAs, began receiving TXA preoperatively. Anesthesia delivered a one-time dose of 20 mg/kg intravenously to all patients at the time of skin preparation. From August 2009 to December 2012, 106 consecutive patients received TXA and were included in this study (TXA group). The TXA group was then compared with the previous consecutive 88 TSAs from January 2007 until August 2009 done without TXA (non-TXA group). Of the 88 non-TXA patients, 43 were anatomic TSAs and 45 received a reverse TSA.

In the acute postoperative period, standardized treatment protocols were used without changes throughout that time period. All patients were immobilized in a sling and swath and had a postoperative blood sample drawn for hemoglobin (Hb) and hematocrit (Hct) determination the morning after surgery. No physical therapy was initiated in the hospital, and patients were discharged home as soon as possible. Descriptive statistics were calculated for all outcomes, including change in Hb and Hct, transfusion rate, length of surgery, length of time in the recovery room, and length of hospitalization. Statistical analyses were performed using χ^2 techniques for categorical variables and analysis of variance. A P value of $<.05$ was considered statistically significant. Data analysis was performed using IBM SPSS version 21 (IBM Corp, Armonk, NY, USA).

Results

There were no significant demographic differences between patients receiving TXA and the non-TXA group with respect to gender, race, surgical side, surgical approach, American Society of Anesthesiologists classification, prosthesis type (reverse vs. anatomic), body mass index, and length of surgery (Table I). The mean TXA dose was 1657 mg, resulting in a mean cost of $68. Overall, 97 patients received an anatomic prosthesis, and 97 patients received a reverse prosthesis.

Compared with preoperative Hb and Hct values obtained a maximum of 4 weeks before surgery, the patients receiving TXA had significantly less blood loss than those who did not receive TXA as measured by the changes in Hb and Hct (Table II). The drop in Hb was significantly less in the TXA group compared with the non-TXA group (TXA group $\Delta = 2.13$ vs. non-TXA group $\Delta = 2.63$; $P = .01$), as was the drop in Hct (TXA group $\Delta = 6.4$ vs. non-TXA group $\Delta = 8.14$; $P < .01$).

There was significantly less time spent in the recovery room (mean, TXA group 69 minutes vs. non-TXA group 87 minutes; $P < .02$) and a shorter overall length of hospitalization (mean, TXA group 1.18 days vs. non-TXA group 1.40 days; $P = .01$) by patients who received TXA vs. those who did not receive TXA (Table II). This means that patients who received TXA spent 21% less time in the recovery room and 16% less time in the hospital. Furthermore, 2 patients in the TXA group received blood transfusions, whereas 6 patients in the group that did not receive TXA received blood transfusions. There were no thromboembolic or cardiac events in any patients in either group.