

Tranexamic Acid in Bolus Alone Vs Bolus and Continuous Infusion in Hip Arthroscopy

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ABSTRACT

AIM: the present study examines the effects of tranexamic acid (TXA) on reducing blood loss during hip arthroscopy, comparing two differ-

ent methods of administration (bolus vs infusion).

METHODS: a prospective study with 70 patients undergoing hip arthroscopy was carried out. The patients within the TXA infusion group (group A) received TXA an 2-g intravenous bolus 30 min before skin incision intravenously followed by 10 mg/kg/h infusion (continued during the entire surgery); whereas group B received TXA as a 2-g intravenous bolus 30 min before surgery. Hemoglobin and hematocrit measures were evaluated before surgery and 24 hours after surgery. Specific statistically methods were considered.

RESULTS: Mean hemoglobin decrease 24 h after surgery was significantly lower ($p = 0.003$) in patients of group A (1.18 +/-0.99 g/dL) than in group B (1.84+/-0.78 g/dL). The mean hematocrit decrease 24 h postoperatively was significantly lower ($p = 0.002$) in patients of group A than in group B (3.52+/-3.37 vs 5.08+/-2.45).

CONCLUSIONS: This prospective clinical study showed that the use of TXA in infusion slows down the hemoglobin and hematocrit loss with respect to the bolus TXA group when the administration combined initial bolus and infusion perfusion during the surgery.

Key words: Tranexamic acid; Hip arthroscopy; Blood loss; Postoperative complications; Tranexamic acid dosage

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INTRODUCTION

Over the past two decades hip arthroscopy has been used as diagnostic and therapeutic tool within hip disease^[1]. Several studies have reported on successful treatment of femoroacetabular impingement, labral tears, chondral defects and round ligament lesions through an arthroscopic approach^[2,3].

Specific training is required to perform arthroscopy and hip

arthroscopy may be particularly difficult due to the arduous access portals and extensive learning curve that it requires^[4]. As all surgical procedure, hip arthroscopy presents complications that have been previously reported, although most of them are temporary and easily avoided with preventive measures^[5-7].

To our knowledge, only one study has previously described bleeding in hip arthroscopy, and no clinical issues were described in the series^[8]. However, blood loss can be a special issue in more susceptible patients, such as cardiac or anemic patients, in whom bleeding could become a potential risk. Blood loss has been described in other orthopedic procedures, such as arthroplasties and anterior cruciate ligament reconstruction^[9-12].

Tranexamic acid (TXA) is a synthetic analog of the amino acid lysine. Its mechanism of action is by competitively blocking the lysine-binding site of plasminogen, which in turn inhibits fibrinolysis^[13]. TXA reduces blood loss in both total hip and knee arthroplasty over a range of dose regimens^[14], without increasing the risk of venous thrombosis events (VTEs)^[15].

The present study evaluates the efficacy of TXA in relation to postoperative blood loss, hemoglobin levels, and the need for blood transfusion following hip arthroscopy, comparing two different methods of administration (bolus alone *vs.* bolus followed by continuous infusion).

METHODS

A prospective clinical study with patients undergoing hip arthroscopy at our institution was carried out. Inclusion criteria were patients undergoing hip arthroscopy due to femoroacetabular impingement and willing to participate in the present study. The exclusion criteria were patients younger than 18 years, bleeding or clotting disorders as hemophilia or protein S or C deficits, preoperative anticoagulation therapy, as dicumarinics or aspirine, an abnormal coagulation profile, renal disorders or insufficiency, sickle cell disease, and allergy to local anesthetics or TXA.

The study sample size was calculated according to the previous studies regarding bleeding within hip surgery^[10,13,14], considering a 5% error, confidence level of 95%, an unknown population (assuming greater than 20,000 and 5% precision). The estimated sample size was of 35 patients of each group (Figure 1).

70 consecutive patients (70 hips) who agreed to participate in the study were prospectively enrolled in the present study, with a diagnosis of femoroacetabular impingement scheduled for a primary hip arthroscopy. The patients were randomized into one (A) or other group (B). The patients' average age, sex and surgical time were evaluated. Surgical time was defined as the time that the surgery lasts for, from the first incision to the last skin suture. No significant differences were observed between both groups regarding the patients' demographics ($p = 0.46$).

The decreases in hemoglobin (Hb) and hematocrit (HCT) were evaluated in all patients. A detailed medical history was obtained for every patient and any associated medical comorbidities were noted.

All patients were evaluated clinically by the same surgeon, operated on by the same surgical team, and anesthetized by the same specialist using an epidural with sedation. Surgery in all patients followed the same procedure; a hip arthroscopy firstly under leg distraction to operate at the joint and evaluate and treat any cartilaginous or labral lesion and pincer-type deformities; and later without traction, to treat Cam-type lesions by osteoplasty with a motorized burr with radiofrequency for hemostatic control. An orthopedic surgeon with over 7 years of experience in hip arthroscopy, performing at least 80

$$N = (Z^2 * p * q) / d^2$$

Figure 1 Z= confidence level (95% → 1.96); d= Precision= 3%; p= approximate proportion = 5%; q= 1-p .

Table 1 Patients' demographics; no significant differences were observed for every variable in both groups.

Variable	Group A (infusion)	Group B (bolus)
n	35	35
Age (years old)	43.10 (DS 13.35)	42.50 (DS 13.91)
Sex (F/M)	17/18	16/19
Operative time (min)	146.14 (DS 36.80)	140.34 (DS 35.67)

Table 2 Hematocrit (HCT) and hemoglobin (Hb) values of both groups before and after surgery. No significant differences were observed before surgery, whereas mean differences before and after surgery show significant differences. In brackets, the Kolmogorov-Smirnov test result; if p value was less than 0.05, the Mann-Whitney U test was used. On the other hand, when p value of the Kolmogorov Smirnov test was greater than 0.05, the applied test was Student's t-test.

	Group A (infusion) (n = 35)	Group B (bolus) (n = 35)	p	Statistical test
Preoperative HCT	43.01 ± 1.27 (p = 0.2)	42.26 ± 4.57 (p = 0.162)	0.35	Student's t-test
Postoperative HCT	39.49 ± 3.45 (p = 0.0001)	37.18 ± 4.60 (p = 0.067)	0.015	Mann-Whitney U test
HCT change	-3.52 ± 3.37 (p = 0.0001)	-5.08 ± 2.45 (p = 0.025)	0.002	Mann-Whitney U test
Preoperative Hb	14.52 ± 1.24 (p = 0.047)	14.30 ± 1.65 (p = 0.2)	0.384	Mann-Whitney U test
Postoperative Hb	13.34 ± 1.45 (p = 0.2)	12.46 ± 1.73 (p = 0.162)	0.024	Student's t-test
Change in Hb	-1.18 ± 0.99 (p = 0.0001)	-1.84 ± 0.78 (p = 0.02)	0.003	Mann-Whitney U test

hip arthroscopies annually, performed the procedure. Surgical times were recorded in all cases, as well as the volume of intraarticular perfusion with physiological saline used during the arthroscopy and surgical infusion pressures.

The patients in group A received an intravenous 2-g bolus TXA (Amchafibrin 500mg/5ml, Rottapharm; Spain) 30 min before surgery and an intravenous infusion of TXA at 10 mg/kg/h during surgery. The group B patients received an intravenous 2-g bolus TXA (Amchafibrin 500 mg / 5 mL, Rottapharm, Spain) 30 min before surgery. Hemoglobin and hematocrit (HCT) were recorded preoperatively and 24 h after surgery.

The Local Ethics Committee gave approval for the present study and informed consent was obtained from all patients.

No patient in the study developed deep vein thrombosis. No active bleeding or anesthetic sensory anomalies occurred during any surgery. No further surgeries were required due to bleeding. No active bleeding was observed during the postoperative hospitalization. None of the patients showed clinical symptoms of anemia (tachycardia, hypertension, or pallor). No patient received a blood transfusion in this study, either during or after surgery.

Patients started walking with the aid of crutches 24 h after surgery, painless with analgesics (acetaminophen 1 g/8h iv) and non-steroidal anti-inflammatory drugs (ibuprofen 600 mg/8 h) and were discharged from hospital 30 h postoperatively.

Statistical analysis

The statistical analysis involved the use of frequency tables for categorical variables. For continuous variables, descriptive

statistics (*n*, mean, median, standard deviation [SD], minimum, and maximum) were tabulated. The pre- and postoperative Hb levels, change in Hb level (preoperative Hb – lowest postoperative Hb) and HCT were analyzed descriptively. Variables that followed a normal distribution (according to Kolmogorov-Smirnov test) were evaluated with parametric tests (Student's *t*-test). For variables that do not follow a normal distribution, non-parametric tests were used (Mann-Whitney *U* test). A power analysis was also conducted and statistical significance was set up at a *p*-value of 0.05, with a 95% confidence interval.

All statistical calculations were performed using the SPSS (Version 20 for Mac).

RESULTS

In Group A (infusion), the mean preoperative Hb was 14.52 g/dL (+/- 1.24 SD), decreasing to 13.34 g/dL (+/-1.45 SD) after surgery. The respective values in the bolus group were 14.30 g/dL (+/-1.65 SD) and 12.46 g/dL (+/-1.73 SD). The mean hemoglobin decrease 24 h postoperatively was lower in patients receiving TXA in infusion (1.18 g/dL +/- 0.99 SD) than in patients receiving a bolus intravenous injection (1.84 g/dL +/- 0.78 SD), being statistically significant (*p* = 0.003) (95% CI, Mann-Whitney *U* test).

Within group A, the mean preoperative HCT level was 43.01% ± 1.27 SD, decreasing to 39.49% ± 3.45 after surgery. For patients from group B the respective values were 42.26% ± 4.57 and 37.18 ± 4.6. The mean hematocrit decrease 24 h postoperatively was lower in patients receiving TXA in group A (3.52 ± 3.7 SD) than in patients of group B (5.08 ± 2.45 SD), (*p* = 0.002) (95% CI, Mann-Whitney *U* test). Parametric test (Student's *t*-test) was used to evaluate the preoperative HCT values as this followed a normal distribution in both groups. The postoperative HCT and difference mean values did not follow a normal distribution, and thus, a non-parametric test (Mann-Whitney *U* test) was used.

The pre- and postoperative Hb levels, change in Hb level, and HCT are shown in Table 2. Groups A and B significantly reduced their Hb and HCT levels. The decrease in mean blood loss was different for both parameters in both groups, observing that this difference was statistically significant.

DISCUSSION

Tranexamic acid significantly minimizes the decrease in Hb and HCT in patients undergoing hip arthroscopy due to FAI (Cam-type lesion), and its administration in infusion is more efficient than in bolus according to the observed results of the present study.

Perioperative bleeding in hip arthroscopy has not yet been described^[5-7], despite several studies describe the complications of hip arthroscopy. The lack of symptoms of bleeding in our series explains why the majority of hip arthroscopists do not describe this problem. The majority of the patients do not have concomitant diseases that could increase the loss of blood.

Complications associated with hip arthroscopy include those due to traction and patient positioning, chondral lesions at the entry portals, the extravasation of irrigation fluid, including into the abdominal cavity^[16,17], and other common problems such as infection, deep vein thrombosis, or the breakage of surgical materials^[6].

Despite the aggressive use of cauterization and hemostatic agents to reduce perioperative transfusion rates as part of our blood conservation program, we believe that we had reached a plateau in our attempts to limit bleeding and therefore sought alternative strategies used in other orthopedic procedures. We reviewed the

literature on the use of antifibrinolytics, specifically TXA, and found that many studies reported that TXA reduced the blood loss and need for transfusion in patients undergoing primary arthroplasty^[13,18-23]. Based on our experience with hip arthroscopy, and the reports of bleeding in other arthroscopic procedures, such as anterior cruciate ligament reconstruction^[12,24], we believe that bleeding can be a problem in the first postoperative hours following hip arthroscopy.

The postoperative decrease in the Hb and HCT after hip arthroscopy should be considered, especially in patients at risk of anemia, such as females with metrorrhagia or athletes with dysmenorrhea. Therefore, we recommend a postoperative determination of Hb and HCT at 24 h for a better medical management of these patients. Previous studies have searched a different method of application other than intravenous to reduce the risks of systemic application^[25]. We observed that the use of TXA in infusion is more efficient than in bolus to decrease the loss of Hb and HCT in hip arthroscopy.

Several limitations of the present study should be considered when reviewing the present manuscript. This study does not attempt to evaluate the lack of intraoperative blood loss in both groups. Secondly, we did not consider the differences in hip arthroscopic procedures used in each patient. Despite the homogeneous diagnosis, treatment have varied (partial labrectomy or labral suture, different grades of chondropathy...) that could have influenced in final bleeding.

Hip arthroscopy causes blood loss and despite the absence of clinical signs, this could be potentially dangerous in patients with anemia or blood disorders. Therefore, it should be considered when planning the surgical procedure in patients with preoperative Hb and HCT levels below safe limits.

CONCLUSION

Overall, hip arthroscopy appears to be safe, but surgeons should consider the possibility of serious postoperative complications. This prospective study showed that TXA reduces blood loss during hip arthroscopy, significantly with TXA infusion with respect to the administration of TXA in bolus, with negligible side effects. Future studies should examine potential predictors of complications such as bleeding that would allow a more thorough preoperative risk assessment.

INFORMED CONSENT

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000.

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