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Bleeding in Hip Arthroscopy. Management of Blood Loss with Tranexamic Acid.

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Published Date: August 16, 2017

ABSTRACT

Background: To assess the effectiveness of two different modalities of administration of tranexamic acid **(TXA)** in the management of postoperative bleeding after hip arthroscopy.

Methods: A prospective study was conducted in 105 patients who underwent hip arthroscopy. Patients in group A did not receive any treatment to prevent bleeding. Patients in the TXA bolus group received TXA as a 10mg/kg bolus 30 min before surgery. Patients in the TXA infusion group received TXA as a 10mg/kg bolus and an intravenous infusion at 2 mg/kg/h for the duration of the surgery. Hemoglobin and hematocrit were measured before surgery and 24 hours after surgery. Statistical significance was defined as $p<0.05$.

Results: The mean hematocrit decrease 24 h postoperatively was significantly lower in the TXA infusion group (-4.05 ± 3.77%) than in the control group (-6.30 ± 2.63%) [p=0.001]). The mean decrease in the Hct TXA bolus group (-5.08 ± 2.45%) was not significant compared to the control group. Changes in Hb values at 24 hours were significantly lower in the TXA infusion group (-1.18 ± 0.99 g/dL) than in the control group (-2.16 ± 0.96 g/dL) (p=0.001). Changes in the Hb bolus group (-1.84 ± 0.78 g/dL) were not significant compared to the control group.

Conclusions: This prospective clinical study showed that TXA infusion plus initial bolus leads to a lower hemoglobin and hematocrit reduction than TXA bolus in patients undergoing hip arthroscopy.

Keywords: Tranexamic acid; Hip; Arthroscopy; Blood loss; Surgical; Postoperative complications

INTRODUCTION

In the last two decades, the use of hip arthroscopy has grown exponentially and today it is considered an effective diagnostic and therapeutic technique for the treatment of hip pathology, especially for femoroacetabular impingement **(FAI)** [1].

As a result of raised awareness, FAI has become established as a causal factor of labrum and chondral injuries [2], which can lead to degenerative joint disease if the impingement mechanism is not addressed [3].

Several studies have described the success of arthroscopic treatment for labrum injury, chondral defects, round ligament injuries or the presence of loose bodies [4-5].

Arthroscopic hip surgery involves an extensive learning curve and requires high proficiency in arthroscopic triangulation [6].

The surgeon's experience is a predictive factor in the postoperative patient follow up [7].

Many publications have described the medical and mechanical complications of this technique, although most are avoidable by implementing preventive measures [8-11]. Postoperative bleeding is a complication that has been described recently, with observation of a significant decrease in hemoglobin and hematocrit postoperatively [12]. Although it is a complication with low clinical impact, it is very important to take it into account in patients with cardiovascular problems or anemia.

Tranexamic acid **(TXA)** is a synthetic analog of the amino acid lysine. It is an antifibrinolytic that competitively inhibits the activation of plasminogen to plasmin [13]. TXA reduces blood loss in both knee and hip arthroplasty [14,15] without an increase in complications such as deep vein thrombosis [16].

To our knowledge, no studies have sought to determine the most effective modality for TXA administration. In this chapter, we look at studies that have been conducted using TXA for management of bleeding in hip arthroscopy. We evaluated the effectiveness of TXA at reducing postoperative bleeding and need for blood transfusion after hip arthroscopy, comparing two different modalities of TXA administration.

MATERIALS AND METHODS

Our centre at Hospital Quiron Barcelona is a national center of excellence in hip pathology and the same surgical team has been performing hip arthroscopy since its inauguration in 2007. In

this period, we observed blood loss associated with this surgery and although this has not led to clinical problems, it represents a potential problem in certain patients with anemia or bleeding diathesis [12].

To evaluate and treat this bleeding, a prospective study was performed between September 2012 and April 2015 in 3 consecutive groups of patients who underwent elective hip arthroscopy (A: Control; B: Bolus; C: Perfusion). Each group consisted of 35 patients. The sample size calculation assumed an error rate of 5%, a 95% confidence level, an unknown population size (assuming more than 20,000) and an accuracy of 5%. The result was 35 patients. The calculation did not take into account loss to follow-up given that the study design necessitated continuous patient monitoring for a short period only (24h).

The inclusion criteria for the 3 groups were patients who underwent hip arthroscopy, diagnosed with CAM-type femoroacetabular impingement, aged over 18 years and preoperative hemoglobin **(Hb)** and hematocrit **(Hct)** values within normal limits.

Patients with blood dyscrasias, anemia, hematopoietic processes, renal disorders, sickle cell disease or previous treatment with anticoagulants were excluded. In the TXA groups, patients with a tranexamic acid allergy were also excluded.

In group A (control group), Hb and Hct were measured - this was an observational group. Group B patients received a TXA bolus of 10 mg/kg (Amchafibrin 500mg/5ml; Rottapharm, Spain) 30 minutes prior to surgery. Group C patients received TXA as a bolus of 10 mg/kg and continuous intraoperative infusion of 2mg / kg / h (Amchafibrin 500mg/5ml; Rottapharm, Spain) (bolus and continuous perfusion **(BCP)** group).

All patients were evaluated by the same surgeon, operated on by the same surgical team and anesthetized by the same anesthesiologist using the same anesthetic technique (epidural and intradural combined with sedation).

The surgery in all cases was hip arthroscopy, initially with traction of the operated leg for the intraarticular approach and treatment of chondral or labral lesions and, secondarily, without traction to treat CAM lesions using a shaver, osteoplasty and radiofrequency for hemostatic control. Both the surgical indication and surgery were performed by an orthopedic surgeon with more than 7 years of experience in hip arthroscopy and more than 100 hip arthroscopies per year.

In all cases, preoperative Hct and Hb levels were recorded 24 hours after surgery, as well as surgical time, volume of intraarticular sodium chloride infused during the intervention and perfusion pump pressure.

All patients included in the present study were informed that the data related to their case would be used for publication. The informed consent obtained in all cases and procedures complied with the Declaration of Helsinki adopted in 1964 and revised in 2013.

STATISTICAL ANALYSIS

The statistical analysis consisted of the use of frequency tables for categorical variables. For continuous variables, descriptive statistics (n, mean, median, standard deviation **(SD)**) were used. Pre- and postoperative levels of Hb and change in Hb and Hct levels were analyzed descriptively. We performed a normality test with the Kolmogorov-Smirnov test **(K-S)** on all continuous variables. Parametric tests of statistical significance (Student's t-test) were used for the statistical analysis of variables that followed normal curves (K-S test with $p > 0.05$). In the variables that did not follow normal curves (K-S test with $p < 0.05$), non-parametric tests were performed (Mann-Whitney U).

A statistical power analysis was performed and p values <0.05 were taken as indicative of statistical significance, and 95% confidence intervals were calculated.

All statistical calculations were performed with the SPSS program (version 20 for Mac).

RESULTS

One hundred and five patients were included in the study (35 in the control group A, 35 in the bolus TXA group B, and 35 in the TXA BCP group C) and completed the study. The mean age, sex and surgical time of patients in the three groups studied were compared (Table 1).

Table 1: Comparison of averages of the variables age, sex, surgical time between groups A, B and C. No significant differences were observed in the distributions of the 3 groups. Hence, groups A, B and C are comparable.

	GROUP A (CONTROL)	GROUP B (BOLUS)	GROUP C (BCP)
n	35	35	35
Age	41.45 (SD 13.08)	40.54 (SD 13.91)	43.37 (SD 13.35)
Sex (M/F)	18 / 17	16 / 19	17 / 18
Surgical Time (min)	140.63 (SD 35.20)	138.34 (SD 35.67)	146.14 (SD 36.80)

In the control group, mean preoperative and postoperative Hct values were 42.07% (SD 2.96) and 35.77 (SD 3.90), respectively. The mean values of preoperative Hct in the bolus group were 42.26% (SD 4.57) and 37.18% (DE 4.60) in the postoperative measurements. The mean postoperative Hct change in patients in the control group was -6.30% (SD 2.63), while in the bolus group the mean change in Hct was -5.08% (SD 2.45). Although the postoperative Hct decrease in the bolus patients was lower than in the control patients, these differences were not statistically significant ($p > 0.05$) (Table 2).

The mean Hb values for the control group were 14.08 g / dL (SD 1.32) preoperatively and 11.91 g / dL (SD 1.51) postoperatively. The respective values in the bolus group were 14.30 g / dL (SD 1.65) and 12.46 g / dL (SD 1.73). The difference between the postoperative and preoperative Hb values was -2.16 g / dL (SD 0.96) in the control patients, and -1.84 g / dL (SD 0.78) in the bolus

group patients. Although the difference between preoperative and postoperative Hb levels was lower in the bolus group than in the control group, this decrease was not statistically significant (p> 0.05) (Table 2).

Table 2: Comparison of results between the Hct and Hb levels of the Control and Bolus groups.

	GROUP A (CONTROL) (*n = 35)*	GROUP B (BOLUS) (*n* = 35)	*p* value	Statistical Test
Hct preoperative	42.07 ± 2.96 (*p*=0.2)	42.26 ± 4.57 (*p*=0.162)	0.835	Student-t
Hct postoperative	35.77 ± 3.90 (*p*=0.001)	37.18 ± 4.60 (*p*=0.067)	0.290	Mann-Whitney-U
Change in Hct	-6.30 ± 2.63 (*p*=0.2)	-5.08 ± 2.45 (*p*=0.025)	0.067	Mann-Whitney-U
Hb preoperative	14.08 ± 1.32 (*p*=0.2)	14.30 ± 1.65 (*p*=0.02)	0.526	Student-t
Hb postoperative	11.91 ± 1.51 (*p*=0.2)	12.46 ± 1.73 (*p*=0.162)	0.166	Student-t
Change in Hb	-2.16 ± 0.96 (*p*=0.2)	-1.84 ± 0.78 (*p*=0.02)	0.259	Mann-Whitney-U

Next, the results obtained in the control group were compared with the results of the TXA BCP group.

The mean preoperative Hct values were 42.07% (SD 2.96) in the control patients and 43.01% (SD 1.26) in the patients in the TXA BCP group. The postoperative mean Hct of the control group was 35.77% (SD 3.90) compared to 39.48% (3.45) in the BCP group, this difference being statistically significant (p = 0.0001). The mean changes in Hb in the control patients were -6.30% (SD 2.63), while for the BCP group these changes were -4.05% (SD 3.77). The difference in changes in Hct levels between the two groups was statistically significant (p = 0.001) (Table 3).

In the control group, preoperative Hb was 14.08 g / dL (SD 1.32) and 11.91 g / dL (SD 1.51) in postoperative controls. For the BCP group, the levels were 14.52 g / dL (SD 1.24) and 13.34 g / dL (SD 1.46), respectively.

The decrease in postoperative Hb from preoperative levels was -2.16 g / dL (SD 0.96) in the control patients and -1.18 g / dL (SD 0.99) in the BCP group. Differences between the two groups were statistically significant for postoperative Hb levels (p = 0.0001) and for changes in postoperative Hb levels compared to preoperative Hb levels (p = 0.001) (Table 3).

Table 3: Comparison of results between the Hct and Hb levels of the Control and BCP groups. Statistically significant results are bolded.

	GROUP A (CONTROL) (*n = 35)*	GROUP C (BPC) (*n* = 35)	*p* value	Statistical test
Hct preoperative	42.07 ± 2.96 (*p*=0.2)	43.01 ± 1.26 (*p*=0.2)	0.09	Student-t
Hct postoperative	35.77 ± 3.90 (*p*=0.001)	39.48 ± 3.45 (*p*=0.113)	**0.0001**	Mann-Whitney-U
Change in Hct	-6.30 ± 2.63 (*p*=0.2)	-4.05 ± 3.77 (*p*=0.001)	**0.001**	Mann-Whitney-U
Hb preoperative	14.08 ± 1.32 (*p*=0.2)	14.52 ± 1.24 (*p*=0.047)	0.194	Mann-Whitney-U
Hb postoperative	11.91 ± 1.51 (*p*=0.2)	13.34 ± 1.46 (*p*=0.2)	**0.0001**	Student-t
Change in Hb	-2.16 ± 0.96 (*p*=0.2)	-1.18 ± 0.99 (*p*=0.0001)	**0.001**	Mann-Whitney-U

Regarding the comparison between the two modalities of TXA administration, no statistically significant differences were observed in the preoperative levels of Hct and Hb between patients in the bolus group and patients in the BCP group.

Postoperative Hct and Hb levels were lower in the bolus group than in the BCP group, with these differences being statistically significant (p = 0.015 and p = 0.024, respectively) (Table 4).

Likewise, changes in Hct and Hb levels were greater in the bolus group than in the BCP group. The differences observed between the two groups were significant for changes in Hct (p = 0.002) and in Hb (p = 0.003) (Table 4).

Therefore, administration of TXA as BCP leads to a lower reduction in postoperative Hct and Hb than TXA as a bolus.

Table 4: Comparison of results between the Hct and Hb levels in Bolus and BCP groups. Statistically significant results are bolded.

	GROUP B (BOLUS) (*n* = 35)	GROUP C (BCP) (*n* = 35)	*p* value	Statistical Test
Hct preoperative	42.26 ± 4.57 (*p*=0.162)	43.01 ± 1.26 (*p*=0.2)	0.35	Student-t
Hct postoperative	37.18 ± 4.60 (*p*=0.067)	39.48 ± 3.45 (*p*=0.113)	**0.015**	Mann-Whitney-U
Change in Hct	-5.08 ± 2.45 (*p*=0.025)	-4.05 ± 3.77 (*p*=0.001)	**0.002**	Mann-Whitney-U
Hb preoperative	14.30 ± 1.65 (*p*=0.02)	14.52 ± 1.24 (*p*=0.047)	0.384	Mann-Whitney-U
Hb postoperative	12.46 ± 1.73 (*p*=0.162)	13.34 ± 1.46 (*p*=0.2)	**0.024**	Student-t
Change in Hb	-1.84 ± 0.78 (*p*=0.02)	-1.18 ± 0.99 (*p*=0.0001)	**0.003**	Mann-Whitney-U

Active bleeding did not occur during surgery in any of the cases studied nor were there any problems related to untoward reactions to anesthesia. None of the patients included in the study had problems of deep venous thrombosis or symptoms of anemia. No surgical revision was required for bleeding or any blood transfusions.

All patients started walking with crutches 24 hours postoperatively and were discharged 30 hours after the intervention.

DISCUSSION

The main finding of this study was the significant decrease in the hematocrit and hemoglobin reduction following hip arthroscopy and the significant decrease in blood loss in patients who were given TXA as a continuous infusion during the intervention.

Although there have been many studies that describe complications in hip arthroscopy, perioperative bleeding has not been described until very recently. Our group observed a blood loss of 0.78 liters and a decrease of 2 and 6 points of Hb and Hct respectively [12]. The scarcity of anemia symptoms in the patients treated may justify the lack of previous publications about this complication.

Complications associated with hip arthroscopy include both mechanical problems of nerve compression resulting from incorrect positioning of the patient at the surgical table with traction, labral and chondral lesions secondary to arthroscopic access portals or rupture of surgical material such as retroperitoneal hematomas, infections, or deep vein thrombosis [8-11]. Bleeding has been a complication described in different orthopedic procedures such as knee and hip arthroplasty and reconstruction of the anterior cruciate ligament [17-22].

Despite the aggressive use of radiofrequency as a cauterizing agent 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 administration reduces blood loss and the need for transfusion in patients undergoing arthroplasty [14,23-28]. Based on prior experience in hip arthroscopy [12] and reports of bleeding in other arthroscopic procedures, such as reconstruction of the anterior cruciate ligament [20,21], we believe that bleeding may be a problem in the earliest postoperative hours.

The postoperative reduction of Hb and Hct levels should especially be considered in patients at risk of anemia; therefore we recommend postoperative control of Hb and Hct for 24 hours for better medical management of our patients [12].

In the present study, we observed a decrease in blood loss in patients given TXA with respect to the control patients (group A); this decrease was only significant when the TXA was administered intraoperatively via continuous perfusion (group C).

Although we observed high levels of blood loss in group A, we did not observe-in common with all other studies-any clinical changes necessitating supportive measures. However it should be borne in mind that the mean age of patients in our study was slightly over 40 years and they had no problems other than their hip problem. Clearly, these patients are not comparable with patients with osteoporotic fractures or patients with osteoarthritis of the knee or hip requiring a prosthesis. These groups are older and tend to have concomitant problems that make them more likely to require blood transfusion for blood loss during surgery, for example. Nevertheless, the lack of symptoms in our group should not make us lower our guard about the possibility of problems with particular sensitivity to blood loss. Higher postoperative blood loss should be anticipated in all patients whose preoperative values lie within the normal range near the lower limit or with mild anemia.

With regard to use of TXA, standard at our center for surgical procedures such as hip and knee prostheses, it was useful when there was proof of blood loss in hip arthroscopy. We described a formulation with sufficient efficacy to reduce blood loss in an effective and statistically significant manner (group C).

Several limitations in this study should be considered in the review of this manuscript. The present study did not aim to measure intraoperative blood loss. Second, we did not consider the different arthroscopic hip procedures performed on each patient (partial labrectomies, labral sutures, different degrees of chondral lesion). To minimize the impact of this factor, the inclusion criterion was restricted to those patients diagnosed with labral lesion and CAM-type deformity requiring resection by femoral osteoplasty, excluding patients diagnosed with pincer- or mixed-type deformity or with labral lesions without the need for femoral osteoplasty, since they could have generated variations in the degree of perioperative bleeding.

The administraton of TXA as a bolus and continuous perfusion has been shown to be an effective method for controlling bleeding in hip arthroscopy, significantly reducing blood loss after the intervention. In spite of this, due to the decrease in postoperative levels of Hb and Hct, we recommend postoperative control of the respective parameters during the first 24 hours after surgery.

ACKNOWLEDGEMENT

We thank Thomas Oxlee for revising and proofreading the article.

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