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Research Article

Oral Tranexamic Acid Does Not Improve Arthroscopic Visibility During Rotator Cuff Repair

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Abstract

Objective: To evaluate the quality of arthroscopic visibility during rotator cuff repair using oral Tranexamic Acid (TXA). Secondary objectives included evaluating whether oral TXA administration has any impact on cerebral oxygenation, mean arterial pressure (MAP), irrigation pump pressures, surgical and anesthetic times.

Methods: A prospective, comparative, randomized, double-blinded study was conducted on patients treated by arthroscopic rotator cuff repair. The sample was divided into 2 groups: group A (n=24) received oral TXA 30 minutes before the procedure and group B (n=20) was the control group without oral TXA. Variables were compared at 4 different surgical moments (tenodesis, rotator cuff repair, subacromial decompression, acromioclavicular decompression). Visibility was categorized into 2 grades (grade I "poor visibility" or grade II "good visibility"), values for cerebral oxygenation, MAP, irrigation pump pressures, surgical and anesthetic times were compared.

Results: The study included 44 patients, with a mean age of 57 years. Visibility was significantly better during tenodesis in group A ($p < 0.001$), but there were no differences at other surgical moments. Cerebral oxygenation was higher in group A ($p < 0.05$) at all surgical moments. There were no statistically significant differences in MAP control, irrigation pump pressures, or surgical and anesthetic times.

Keywords: *Rotator Cuff, Tranexamic Acid, Arthroscopy, Cerebral Oxygenation*

1. Introduction

Rotator cuff injuries affect 30-50% of individuals over 50 years old and are a common cause of limited function, pain, and shoulder weakness [1]. During rotator cuff repair surgery, maintaining adequate visibility is crucial for a successful arthroscopy [1–4]. Various methods have been proposed to limit intraoperative bleeding and improve visibility during the procedure, including the use of mechanical irrigation pumps, induced hypotensive anesthesia, and epinephrine in the irrigation solution [5–8], and recently intravenous tranexamic acid (TXA) [2].

TXA is an analog of lysine that competitively blocks the binding of plasminogen to tissue plasminogen activators, thereby inhibiting fibrinolysis [9–12]. Benefits of oral TXA include reduced intraoperative bleeding, decreased levels of D-dimer, and inflammatory markers [9,13–23].

TXA has proven to be a safe medication without increasing the risk of thromboembolic or renal complications [24]. However, the optimal dosage and route of administration are still debated [9,13–15,18,19,25]. A previous study demonstrated that intravenous TXA is a safe alternative to improve visibility in shoulder arthroscopic surgery, as well it is effective in reducing pain and analgesic consumption in the immediate postoperative period [2]. However, there are no studies demonstrating the efficacy of oral TXA to improve visibility in shoulder arthroscopic surgery for rotator cuff repair.

The main objective of this study was to 1.- evaluate the effect of oral TXA on arthroscopic visibility during rotator cuff repair. Secondary objectives included evaluating 2.- the effect on cerebral oxygenation, 3.- effect on MAP control, 4.- effect on irrigation pump pressures, and 5.- the effect on surgical and anesthetic times. The hypothesis of this study is that the administration of 1300 mg of TXA orally 30 minutes prior to surgery is associated with better visibility, improved cerebral oxygenation, better MAP control, lower irrigation pump pressures, and shorter surgical and anesthetic times during arthroscopic rotator cuff repair.

2. Methods

A prospective, randomized, double-blinded, controlled study was conducted between March 2020 and March 2022. Patients aged 18 to 65 with a surgical rotator cuff injury confirmed by simple shoulder MRI were included. Patients with severe arthritic changes (Hamada >2), tendon retraction Patte >II, fatty infiltration Goutallier >3, previous shoulder surgery, fractures, renal or liver disease, coagulation disorders, or known allergies to TXA were excluded. After approval from the research and ethics committee at Hospital Ángeles de Querétaro, all candidates were informed about the study objectives and signed an informed consent. Randomization was performed by drawing lots, where patients randomly selected one of two envelopes containing the letter “A” or “B.” Patients who obtained letter “A” (group A) were assigned to the experimental group and received oral TXA (2 tablets of 650 mg of tranexamic acid [Lysteda®] for a total of 1300 mg 30 minutes prior to surgery), while patients who obtained letter “B” (group B) were assigned as the control group without TXA. Surgical technique, postoperative indications, and general measures were the same for all patients.

2.1 Surgical Technique

The surgical intervention in all cases was performed by the same surgeon trained in shoulder surgery (A.G.A). Anesthetic management involved brachial plexus block guided by Doppler ultrasound and combined general anesthesia. Continuous monitoring of cerebral oxygen saturation, capillary oximetry, capnography, anesthetic agent concentration, biespectral monitoring was performed. Heart rate, blood pressure, ventilation parameters and temperature were documented throughout the procedure. Surgery was performed in the beach chair position. Conventional portals (posterior, posterolateral, lateral, anterior, and anterolateral) were used. Clear plastic cannulas of 8 mm were used in the anterior and lateral portals. Tenodesis or tenotomy was decided based on the intraoperative conditions of the long head of the biceps tendon and the integrity of the bicipital pulley. The rotator cuff was repaired in a double-row configuration. Finally, subacromial and acromioclavicular decompression were performed, leaving the coracoacromial ligament intact when indicated. A continuous fluid flow system was used with a preset pressure of 60 mmHg.

2.2 Evaluated Variables

Evaluated variables included: Surgical field visibility (grade I or II), cerebral oxygenation, MAP, irrigation pump pressures, and surgical and anesthetic times. Surgical field visibility was categorized into two grades: Grade I referred to poor arthroscopic visibility [Figure 1] and Grade II referred to good arthroscopic visibility [Figure 2]. Each variable was measured at four different surgical moments: biceps tenotomy or tenodesis (moment 1), during rotator cuff repair (moment 2), subacromial decompression (moment 3), and during acromioclavicular decompression (moment 4).

2.3 Statistical Analysis

Normality (Shapiro-Wilk) and homogeneity of variances (Levene) were verified for numerical variables. Student’s t-test for independent samples was used to determine differences between means of both cohorts. One-way ANOVA was employed to establish differences in control variables: age, pump pressure, cerebral oxygenation, and MAP at the four surgical moments. Binary logistic regression was performed to determine the impact of TXA on surgical field visibility and its relation to confounding or controlled variables. A p-value <0.05 was considered indicative of statistical significance. All analyses and calculations were made using SPSS software (version 29.0; IBM Corp., Armonk, NY).

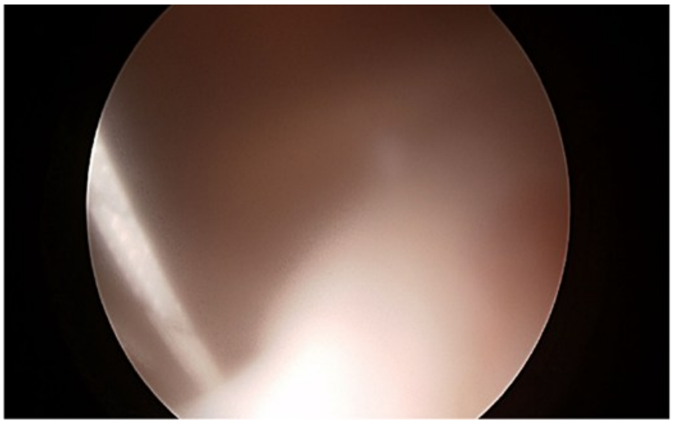

Figure 1. *Visibility grade I.*

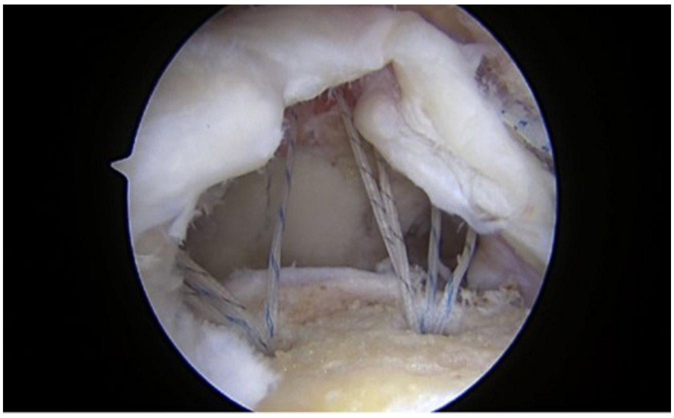

Figure 2. *Visibility grade 2.*

3. Results

The study was conducted from March 2020 to March 2022, including 59 patients who met inclusion criteria. Of these, 15 patients were excluded for lacking complete records. No patients were lost during follow-up. Finally, a total of 44 patients were recruited for this study. Of the patients, 24 received oral TXA (group A) and 20 did not (group B). The mean age was 57 years (± 10.1). There were no significant differences between groups A and B in demographic data except for age, with the mean age being lower in group A (Group A: 54.08 ± 9.45 years; Group B: 62.6 ± 9.1 years; p = 0.004). [Table 1].

Table 1. Demographic data of Group A and Group B.

	Group A (with TXA) (n= 24)	Group B (control) (n=20)	*P value*
Age	54.08 (±9.45)	62.6 (± 9.1)	<0.004
Weight	75.33 (± 17.1)	71.4 (± 13.8)	>0.05
Height	164.9 (± 9.4)	163.1 (± 9.17)	>0.05
BMI	27.45 (± 4.59)	26.72 (± 4.15)	>0.05
TXA = Tranexamic Acid; BMI = Body Mass Index.			

3.1 Effect of Tranexamic Acid on Surgical Field Visibility

A significant improvement in visibility was observed during tenotomy (moment 1) in group A with TXA (p<0.001). No significant differences in visibility were found at other surgical moments. [Table 2].

Table 2. Results in arthroscopic visibility between Group A and Group B.

Surgical Moment	Visibility	Group A (with TXA)	Group B (control)	*P value*
Tenodesis	Yes	23 (95.8%)	16 (80%)	<0.001
	No	1 (4.16%)	4 (20%)	
Rotator Cuff Repair	Yes	15 (62.5%)	14 (70%)	>0.05
	No	9 (37.5%)	6 (30%)	
Subacromial decompression	Yes	17 (70.8%)	11 (55%)	>0.05
	No	7 (29.16%)	9 (45%)	
Acromioclavicular decompression	Yes	15 (62.5%)	12 (60%)	>0.05
	No	9 (37.5%)	8 (40%)	
TXA = Tranexamic Acid.				

3.2 Effect of Tranexamic Acid on Cerebral Oxygenation, Blood Pressure, Irrigation Pump Pressures, Surgical and Anesthetic Times

Cerebral oxygenation was significantly higher in group A with TXA ($p<0.05$) at all surgical moments. No statistically significant differences were observed between both groups regarding MAP control ($p>0.05$). There was no significant difference in irrigation pump pressures when compared between groups ($p>0.05$). Surgical time was similar in both groups (group A: 83.6 ± 33.3 minutes; group B: 84.2 ± 42.6 minutes; $p=0.389$) ($p >0.05$). Also, anesthetic time was similar in both groups (group A: 147.2 ± 42.1 minutes; group B: 147.6 ± 47.4 minutes) ($p >0.05$).

4. Discussion

Our study demonstrates that the use of oral TXA 30 minutes prior to arthroscopic rotator cuff repair significantly improves the visibility of the surgical field during the tenotomy of the long head biceps but does not influence visibility during the other surgical moments. In our institution, we have observed good results with the use of oral TXA [26,27] in reducing intraoperative blood loss during total hip and knee replacement procedures. Despite the good outcomes with TXA in joint replacement surgeries, the efficacy of oral TXA in shoulder arthroscopy compared to various methods for controlling intraoperative bleeding remains a topic of debate. The method of choice to improve arthroscopic visibility also carries specific risks of complications for each of them; for instance, the use of radiofrequency may not control bleeding during acromioplasty, while irrigation pump pressure can lead to extravasation into soft tissue, causing pain, nerve or vascular compression [28]. Epinephrine in solutions has documented adverse reactions, including cardiovascular collapse secondary to ventricular tachycardia [29,30] and pulmonary edema [31], and there is a cytotoxic effect even at low concentrations of 1:1000 ml [32–35]. TXA at doses of 20-100 mg/ml used locally has shown good results in controlling intraoperative bleeding, with low cytotoxicity [36–38].

As secondary outcomes, there was a significant improvement in cerebral oxygenation in the TXA group throughout the procedure, suggesting that TXA could have a beneficial effect on cerebral oxygenation after anesthesia and during shoulder arthroscopy. No significant differences were found in the management of mean arterial pressure (MAP), irrigation pump pressures, or surgical and anesthetic times. The lack of a significant effect on overall visibility could be explained by the multifactorial nature of visibility in shoulder arthroscopy. Our results suggest that adequate control of intraoperative MAP may be the most influential factor on visibility. Unlike the work of Liu et al. [2], we included the relationship between visibility and MAP values, pump pressure, and cerebral oxygenation at all or some moments during the surgical procedure. The significant improvement in cerebral oxygenation observed in the TXA group is a relevant finding, considering the potential risks of cerebral hypoperfusion associated with the beach chair position during shoulder arthroscopy. It is important to note that in the anesthetic framework, the use of hypotensive agents is not without adverse effects or complications that, while rare, can be catastrophic, particularly in patients with cardiovascular pathology, where cerebral arterial circulation may be compromised, leading to cerebral ischemia, shock, neurological deficiency, or death [39]. Therefore, it has been established that all patients should maintain cerebral oxygenation >50% [40]. In our practice, one of the most useful tools for proper management of controlled hypotension is continuous monitoring of cerebral oxygenation by the anesthesia team, thereby reducing risks and complications of cerebral hypoxia associated with low MAP levels in beach chair position procedures. For this reason, we suggest standardized monitoring of cerebral oxygenation using specific sensors.

In this study, we observed data of transient cerebral hypoperfusion <50% in some patients with increased MAP. This effect could be interpreted as a "cascade effect," referring to cerebral hypoperfusion due to the increased MAP from the beach chair position [40]. For all the above reasons, interscalene regional block inhibits sympathetic stimulation and prevents increases in systemic arterial pressure and vascular resistance [41–43].

Morrison et al. [44] observed improved visibility when maintaining a difference between systolic blood pressure and pump pressure <49 mmHg. Previous published studies support our conclusions and our anesthetic protocol for shoulder arthroscopy aimed to improve intraoperative bleeding and thereby improving visibility [44–48]. On the other hand, Choi et al. [45] observed the positive effect of interscalene block in decreasing elevations in systemic blood pressure and heart rate during subacromial decompression, improving visibility during the procedure. In patients with general anesthesia as the only modality, patients continue to receive nociceptive stimuli, especially during acromioplasty when cortical bone is removed, which raises blood pressure, heart rate, and bleeding [45].

A strength of our study is the comparison of MAP values between groups divided by visibility, where Grade I visibility improves with adequate MAP control, being the most important factor in arthroscopic visibility. Limitations of the study include the subjective evaluation of visibility, lack of multiple evaluators, and a relatively small sample size. The selection, randomization, and blinding methods could be strengthened in future studies. The control of confounding variables, homogeneity of groups and the variability in surgical treatment should be considered in subsequent research.

5. Conclusions

The use of oral TXA 30 minutes before arthroscopic repair of the rotator cuff improves visibility during tenotomy. It also improves cerebral oxygenation throughout the procedure. However, it does not significantly affect the overall visibility of the surgical field. Visibility appears to be more related to the control of systemic blood pressure rather to the use of TXA. It is recommended to maintain controlled hypotension with adequate monitoring of cerebral oxygenation to optimize visibility and avoid neurological complications, as proper control of mean arterial pressure (MAP) seems to be the most related factor to adequate visibility during shoulder arthroscopy. Additional studies with larger sample sizes and control of variables are needed to confirm these findings and assess the long-term safety of oral TXA in shoulder arthroscopic surgery.

Conflicts of Interest

The authors declare no conflicts of interest.

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