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Benefits of Using Tranexamic Acid in Spinal Deformity Surgery

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Abstract

Background: Spinal deformity surgeries are often associated with a high incidence of perioperative blood loss, which poses several complications. Much current research focuses on the importance of antifibrinolytic drugs during spinal surgeries to reduce blood loss, which can also reduce the risk of the need for blood transfusions. We evaluated the effects of using high-dose tranexamic acid (TXA) in spinal deformity surgeries on blood loss, blood transfusions, and associated complications.

Aim of Study: Assessing the efficacy of using Tranexamic acid in deformity spine surgery regarding blood loss and the need of blood transfusion.

Patients and Methods: 20 patients with spine deformities that were surgically corrected in Cairo and Fayoum University hospitals between October 2023 and April 2024 were included. The patients were divided into 2 groups; Group A included patients who received TXA intraoperative while Group B included patients who didn't receive TXA.

The TXA regimen was 50mg/Kg as loading 15-20 minutes pre-surgical incision then 20mg/Kg as a maintenance dose every hour till the end of surgery.

Results: There were no significant differences between the study groups in terms of intraoperative blood loss, as the mean blood loss intra-operative in the TXA group was 0.8 L ± 0.4 L while in the control group, it was 0.85 L ± 0.4 L but there was significant difference in post-operative bleeding as Mean blood loss post-operative in TXA group is 0.31 L ± 0.06 L while in the control group was 0. 51 L ± 0.1 L. The median range of Packed red blood cells (PRBCs) or plasma transfusion intra-operative in both groups is 0 to 1.5.

The median range of PRBCS or plasma transfusion post-operative is 0 in the TXA group, and 0 to 1 in the control group. The median time of drain removal in the TXA group was 2.5 days while 3 days in the control group.

Conclusion: We found the use of TXA was effective in reducing surgical bleeding and postoperative transfusion volume for patients undergoing spinal deformity surgeries. However, there was not a statistically significant effect of TXA on the overall clinical outcome.

Key Words: *Blood loss – Blood transfusion – Intraoperative – Scoliosis – Postoperative – Tranexamic acid.*

Introduction

SPINAL deformity surgery has the potential for massive blood loss, especially during long-level lumbar or thoracic instrumented fusion with or without osteotomy, blood loss may be substantial, and transfusion is required in most cases *[1-4]*.

Therefore, there have been many options in blood conservation strategies to reduce surgical bleeding and intraoperative allogeneic blood transfusions like patient positioning to avoid abdominal compression, hypotensive anesthesia, application of topical hemostatic agents to the decorticated bone, intra-operative cell salvage (ICS) system, and administration of medications *[3-6]*. Recently, the use of antifibrinolytics has become popular in major spinal surgeries *[1,4,5,7-9]*.

Tranexamic acid (TXA) is a synthetic antifibrinolytic amino acid derivative that forms a reversible complex with both plasminogen and plasmin by binding at lysine binding sites *[7-10]*. This binding completely blocks the interaction of plasminogen and plasmin with lysine residues on the surface of fibrin, thereby preventing the proteolytic action of plasmin on fibrin and inhibiting fibrinolysis at the surgical wound *[7-10]*.

Although several studies reportedthat TXA use demonstrated favorable results in spinal surgery,

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List of Abbreviations:

AIS : Adolescent Idiopathic Scoliosis.
TXA : Tranexamic acid.
PRBCs : Packed red blood cells.
ICS : Intraoperative Cell Saver.
Hb : Hemoglobin.

there still exists inconsistency [7-10]. The purpose of this study was to evaluate the effectiveness and safety of using TXA in spinal deformity surgery.

Much of the available research focuses on the importance of using antifibrinolytic drugs during spinal surgeries to decrease blood loss, which can decrease the risks of associated blood transfusions [8-13]. However, optimal dosing and patient selection guidelines and drug safety profiles have not yet been fully established. Therefore, in this study, we evaluated the effects of a prophylactic, high dose of TXA in spinal fusion surgeries on blood loss and the incidences of blood transfusions and associated complications.

Material and Methods

Our study was a prospective randomized controlled comparative study of 20 patients with spine deformities such as scoliosis, kyphosis, kyphoscoliosis, and hemivertebra will be operated by posterior spinal fixation 5 levels or more in Cairo and Fayoum University Hospitals between October 2023 and April 2024. The patients were divided into 2 groups; Group A included patients who received TXA intraoperative while Group B included patients who didn't receive TXA. The TXA regimen was 50mg/Kg as loading 15-20 minutes pre-surgical incision then 20mg/Kg as a maintenance dose every hour till the end of surgery as Preoperative Evaluation. All patients were subjected to thorough history taking, clinical and radiological evaluation.

The perioperative parameters examined in this study included the following: Pre-operative Hb, intraoperative blood loss, need for allogenic packed red blood cell (PRBC) transfusion, volume of fluid transfusion, duration of surgery, and urine output. The postoperative parameters examined were postoperative HGB, blood loss, time until drain removal, the need for blood transfusions during postoperative recovery, discharge from the hospital, and any other postoperative complications.

All data were verified, coded by the researcher, and analyzed using IBM-SPSS 21.0 (IBM-SPSS Inc., Chicago, IL, USA).

Results

In the TXA group, most patients were males, in the controlled group, males and females were equal. Most deformity encountered was Dorso-lumber scoliosis, one case with hemivertebra, and one case of Scheuermann kyphosis. Neuromonitoring was used in most patients in both groups. The mean time of surgery was 4 to 6 hours in the TXA group and 3.5 to 6 hours in the control group. Table (1) summarizes the preoperative clinical and radiological data of the patients.

There was nota statistically significant difference between the study groups regarding intraoperative blood loss, as the mean blood loss intra-operative in the TXA group was 0.8 L ± 0.4 L while in the control group, it was 0.85 L ± 0.4 L, however; there was a significant difference in post-operative bleeding as the mean blood loss post-operative in TXA group is 0.31 L ± 0.06 L while in the control group was 0. 51 L ± 0.1 L. The median time of drain removal in the TXA group was 2.5 days while 3 days in the control group.

The median range of preoperative Hb in both groups was 12-15gm/dl. Our study revealed that TXA has a positive effect in preventing Hb drop post-operative because the mean Hb post-operative in the TXA group is 11gm/dl, and in the control group is 9gm/dl (Table 2). This effect making TXA use is advisable especially if the Cobb angle of the curve is large and prolonged surgery is predicted.

The mean blood loss intra-operative in the TXA group was 0.8 L ± 0.4 L while in the control group was 0.85 L ± 0.4 L. The mean postoperative blood loss in the TXA group is 0.31 L ± 0.06 L while in the control group was 0. 51 L ± 0.1 L.

The intraoperative use of TXA decreases intra and post-operative blood loss which would make the surgical field better for the surgeon to operate, and make the drain removal faster, and this will be followed by shorter hospital stays.

Table (1): Clinical and Radiological Features of the patients.

	TXA (n=10)	Control (n=10)	*p*-value
Sex:			
- Male	7 (70%)	5 (50%)	0.325
- Female	3 (30%)	5 (50%)	
Deformity:			
- Dorsal Kyphoscoliosis	0 (0%)	1 (10%)	0.741
- Dorsal Scoliosis	1 (10%)	1 (10%)	
- Dorso-Lumbar Scoliosis	7 (70%)	4 (40%)	
- Double Thoracic Scoliosis	2 (20%)	1 (10%)	
- Hemivertebrae	0 (0%)	1 (10%)	
- Post-traumatic Kyphosis	0 (0%)	1 (10%)	
- Scheunemann Kyphosis	0 (0%)	1 (10%)	
Levels of Fixation:			
- T2 to L1	0 (0%)	2 (10%)	0.380
- T2 to L2	2 (20%)	3 (30%)	
- T2 to L3	1 (10%)	0 (0%)	
- T2 to L4	0 (0%)	1 (10%)	
- T3 to L3	1 (10%)	0 (0%)	
- T3 to L4	3 (30%)	0 (0%)	
- T4 to L4	2 (20%)	1 (10%)	
- T9 to L1	0 (0%)	2 (10%)	
- T9 to L4	1 (10%)	2 (10%)	
- T10 to L3	0 (0%)	1 (10%)	
Duration Surgery (hours):			
- Mean ± SD	4.75±0.6	4.90±0.7	0.481
- Median	4.5 (4-6)	5 (3.5-6)	

Table (2): The Effect of the use of Tranexamic acid on the hemoglobin level.

	TXA (n=10)	Control (n=10)	*p*-value
Preoperative Hb (g/dl):			
- Mean ± SD	13.48±0.7	13.00±0.9	0.105
- Median (Range)	13 (12.5-15)	12.9 (12-15)	
Post-operative Hb (g/dl):			
- Mean ± SD	11.55±1.9	9.39±1.1	0.004
- Median (Range)	11.5 (9-16)	9 (8-11)	

Table (3): The Effect of the use of Tranexamic acid on packed RBCs/Plasma transfusion.

	TXA (n=10)	Control (n=10)	*p*-value
Intra-operative Transfusion:			
- Mean ± SD	0.75±0.5	0.85±0.5	0.631
- Median (Range)	1 (0-1.5)	1 (0-1.5)	
Post-operative Transfusion:			
- Mean ± SD	0.00±0.00	0.4±0.2	0.143
- Median (Range)	0.0 (0-0)	0 (0-1)	

Discussion

Scoliosis is a complex three-dimensional deformity with lordosis, lateral deviation, and axial rotation of the spine. Spinal deformities are associated with perioperative blood losses that are substantially greater than blood loss associated with spinal surgeries [6,14-16]. Techniques such as hypotensive anesthesia, patient positioning, and hemodilution reduce blood loss and may be supplemented to reduce perioperative blood loss, further numerous strategies designed to limit perioperative blood loss are currently available for surgeons treating complex spinal disorders [8-12]. These strategies can be divided into the following categories: Augmentation of red blood cell production, intraoperative antifibrinolytic administration, topical thrombotic agents, and blood salvage [8-12].

The lysine analog antifibrinolytics (aminocaproic acid and tranexamic acid) are substantially less expensive than aprotinin, and although the hemostatic benefits of aminocaproic acid and tranexamic acid may not be as great as aprotinin, much of the early enthusiasm regarding the efficacy of aprotinin to reduce intraoperative and postoperative blood loss in spinal surgery has been tempered by more recent reports of increased adverse renal, cardiovascular, and cerebrovascular events associated with aprotinin [4,5,7,8,12,17]. The benefits of aminocaproic acid and tranexamic acid may be evaluated best by total perioperative EBL, rather than just intraoperative EBL [11,12,17].

Topical hemostatic agents are effective in helping maintain local hemostasis in spine surgery [2]. In this prospective randomized controlled comparative study, 20 patients with spine deformities were surgically corrected in Cairo and Fayoum University hospitals between October 2023 and April 2024. The patients were divided into 2 groups; Group A included patients who received TXA intraoperative while Group B included patients who didn't receive TXA. The TXA regimen was 50mg/Kg as loading 15-20 minutes pre-surgical incision then 20mg/Kg as a maintenance dose every hour till the end of surgery. In the present study, we found the use of TXA was effective in reducing surgical bleeding, and postoperative transfusion volume for patients undergoing spinal deformity surgeries. Also, there was a less postoperative drain amount in the TXA group, although the differences did not reach statistical significance. These results were concordant with most previous studies and recently published meta-analyses [4,5,17].

In our study 20 patients aged between 12-22 years old, there were 12 males and 8 females, and 10 patients received TXA. Xie et al., studied 59 patients aged between 7-45 years old, 26 males, and 33 females, 26 of them received TXA [9], Lykissas et al., studied 49 patients aged between 11-19 years old, 6 males, 43 females, 25 of them received TXA [13]; Baldus et al., studied 44 patients aged between 39-76 years old, 9 males, 35 females, 20 of them received TXA [1], Sethna et al., studied 30 patients aged between 8-18 years old, 16 males, 14 females, 20 of them received TXA; Peters A et al., studied 52 patients aged between 18-80 years old, 20 males, 32 females, 19 of them received TXA [8]; and Verma et al., studied 125 patients aged between 12-18 years old, 50 males, 14 females, 36 of them received TXA [7].

In this study the main pathology was Adolescent Idiopathic Scoliosis (AIS) (thoraco-lumber), one case of hemi-vertebra, and one case of Scheuermann kyphosis. Xie et al., mainly operated upon thoracic scoliosis in Adolescent and Adult idiopathic scoliosis [9], Lykissas et al., studied Adolescent idiopathic scoliosis mainly [13]; Sethna et al., studied 22 patients with Adolescent idiopathic scoliosis and 22 patients with 2ry scoliosis [12], and Verma et al., studied mainly Adolescent idiopathic scoliosis [7].

In this study 2 surgeons operated upon all cases, using TXA in 10 cases in high doses (50mg per kg then 20mg per kg), all in the same technique (post spinal fusion with Ponte osteotomy + or – thoracoplasty with mean fused levels 10-15 level. In Xie et al study, the cases were operated upon all cases, using TXA in 10 cases in high doses (100mg per kg then 10mg per kg), all in the same technique as our study + vertebral column resection (post spinal fusion with Ponte osteotomy + or – thoracoplasty with mean fused levels 12 + or – 5 levels [9].

In the Lykissas et al., study the cases were operated by a single surgeon using TXA in high doses (100mg per kg then 10mg per kg), all in the same technique (post spinal fusion with Ponte osteotomy + or – thoracoplasty with mean fused levels 6-15 level [13]. In the study reported by Baldus et al., the cases were operated by 2 surgeons using TXA in high doses (10mg per kg then half mg per kg), all in the same technique (post spinal fusion with Ponte osteotomy + or – thoracoplasty with mean fused levels 6-15 level [1]. In the study reported by Sethna et al., the cases were operated by 2 surgeons using TXA in high doses (100mg per kg then 10mg per kg as maintenance), all in the same technique (post spinal fusion with Ponte osteotomy + or – thoracoplasty with mean fused levels 6-12 level [12]. In the study reported by Peters et al., the cases were operated on by 2 surgeons using TXA (10mg per kg then 1 mg per kg as maintenance), all in the same technique (post spinal fusion with Ponte osteotomy + or – thoracoplasty with mean fused levels 5 levels or more [8]. Verma et al., used TXA in a low dose (10mg per kg then 1mg per kg as maintenance), and 2 surgeons operated with mean fused levels 6-12 levels [7].

In our study, we found blood loss in the TXA group was 0.4 L to 2 L while in the control group bleeding loss was 0.5 to 2.3 L. Blood transfusion amounts were in the TXA group 0 to 1.5 L while in the controlled group blood transfusion amount were 0 to 1.5 L also. Xie et al., blood loss in the TXA group was 2.5 L (±) 1.6 L while in the control group bleeding loss was 4.7 L (±) 4.7 L [9]. Lykissas et al., blood loss in the TXA group was 537ml (±) 320 ml while in the controlgroup bleeding loss was 1.2 L (±) 896ml Blood transfusion amount was in the TXA group 1.7 L + or – 1.3 L while in the controlled group blood transfusion amount was 3.2 L +or – 2.9 L [13]. Baldus et al., reported blood loss in the TXA group was 2.1 L (±) 1 L while in the control group bleeding loss was 2.2 L (±) 1.5 L and the blood transfusion amount was in the TXA group 1.8 L (±) 1 L while in the controlled group blood transfusion amount was 1.5 L (±) 1.2 L [1]. Sethna et al., reported the blood loss in the TXA group was 1 L (±) 400ml while in the controlled group bleeding loss was 1.4 L (±) 650ml, theblood transfusion amount was in the TXA group 800ml (±) 500ml while in the controlled group blood transfusion amount was 1.3 L (±) 700ml [12].

Pernik et al., reported that TXA appears to provide a protective effect against blood loss in long-segment spine fusion surgery specifically when pelvic dissection and fixation are performed. TXA also seems to decrease postoperative transfusion requirements without increasing the risk of adverse thrombotic events [18].

A meta-analysis concludes that the use of TXA is effective in reducing intraoperative, postoperative, and total blood loss and transfusion rates in spine surgery [4]. We concluded that the average reductions in intraoperative, postoperative, and total surgical bleeding in spine surgery were 219, 119, and 201ml, respectively; with a 33% reduction in transfusion rates when TXA was administered. However, the number of studies that reported on each outcome was not consistent, resulting in anapparently greater reduction in intraoperative blood loss than total blood loss. Nonetheless, the evidence on the efficacy of TXA in reducing surgical bleeding in spine surgery is overwhelming [4].

Baldus et al., concluded in their retrospective study in 2010 in patients undergoing lumbar pedicle subtraction osteotomy that TXA use did not decrease surgical bleeding or intraoperative transfusion amount whereas using aprotinin did [1].

A double-blinded study in Boston Pediatric Hospital in 2005 used TXA in a high dose and concluded that the dose of TXA reduced surgical blood loss but had no effect on blood transfusion requirements, they recommended doing a large prospective controlled trial is necessary to determine the potential for reducing blood loss and transfusion requirements in patients with primary scoliosis, secondary scoliosis, or both [12].

Previous studies reported inconsistent results regarding hematologic profiles, some researchers found that postoperative hematocrit was significantly higher in the TXA group than control group [13,18]. On the other hand, we found only a statistically insignificant trend toward higher postoperative hemoglobin levels in the TXA group, which was following the results described by Peters et al. [8].

In 2013 a double-blind study by Peters et al., concluded that for patients age over fifty years old, intraoperative blood loss in both TXA and EACA groups was less than control [8]. Similarly, TBL was reduced in TXA and EACA compared to saline in patients aged over fifty years old, and for patients aged below fifty years old, there was statistically no difference between groups in terms of intraoperative and TBL [8]. However, there was no difference in intraoperative or postoperative transfusion rates between other groups. No difference was noted in postoperative blood loss or change in hematocrit [8]. Another issue with the use of TXA is safety concerns, the primary concern with the use of TXA is the potential for an increased risk of thromboembolic complications such as peri-operative myocardial infarction, stroke, deep vein thrombosis, and pulmonary embolism [4,5,17]. Also, there have been reports that the use of high-dose TXA resulted in seizures in patients undergoing cardiac surgery. However, there has been no case reporting seizures associated with TXA use in patients having spine surgery [4,5,17].

In the present study, we found the use of TXA was effective in reducing surgical bleeding, and postoperative transfusion volume for patients undergoing spinal deformity surgeries. Also, there was a less postoperative drain amount in the TXA group, although the differences did not reach statistical significance. These results were concordant with the majority of previous studies and recently published meta-analyses **[5,7,8,11,12,15,17]**. These inconsistent results may warrant a greater number of future refined studies, despite the high level of evidence studies favor the use of TXA in spinal surgery

Conclusion:

Tranexamic acid is effective in reducing surgical bleeding and postoperative transfusion volume for patients undergoing spinal deformity surgeries. However, there was not a statistically significant effect of Tranexamic acid in the overall clinical outcome.

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فوائد استخدام حمض الترانيكسمك
فى عمليات تشوه العمود الفقرى

غالبًا ما ترتبط جراحات تشوه العمود الفقرى بارتفاع معدل فقدان الدم في الفترة المحيطة بالجراحة، مما يشكل مضاعفات عديدة. تركز الكثير من الأبحاث الحالية على أهمية الأدوية المضادة لتحلل الفيبرين أثناء العمليات الجراحية للعمود الفقرى لتقليل فقدان الدم، مما قد يقلل أيضًا من خطر الحاجة إلى عمليات نقل الدم. قمنا بتقييم آثار استخدام جرعة عالية من حمض الترانيكساميك (TXA) فى جراحات تشوه العمود الفقرى على فقدان الدم، ونقل الدم، والمضاعفات المرتبطة بها.

الهدف من الدراسة: تقييم مدى فعالية استخدام حمض الترانيكساميك فى جراحة تشوه العمود الفقرى فيما يتعلق بفقد الدم والحاجة إلى نقل الدم.

لم تكن هناك فروق ذات دلالة إحصائية بين مجموعتى الدراسة من حيث فقدان الدم أثناء العملية، حيث كان متوسط فقدان الدم أثناء العملية فى مجموعة TXA ٠,٨ لتر ± ٠,٤ لتر بينما فى المجموعة الضابطة، كان ٠,٨٥ لتر ± ٠,٤ لتر L ولكن كان هناك اختلاف كبير فى النزيف بعد العملية الجراحية حيث كان متوسط فقدان الدم بعد العملية الجراحية فى مجموعة TXA هو ٠,٣١ لتر ± ٠,٠٦ لتر بينما كان فى المجموعة الضابطة ٠,٥١ لتر ± ٠,١ لتر. خلايا الدم الحمراء (PRBCs) أو نقل البلازما أثناء العملية فى كلا المجموعتين هو ٠ إلى ١,٥.

النطاق المتوسط لـ PRBCS أو نقل البلازما بعد العملية الجراحية هو ٠ فى مجموعة TXA، ومن ٠ إلى ١ فى المجموعة الضابطة. كان متوسط وقت إزالة التصريف فى مجموعة TXA ٢,٥ يومًا بينما كان ٣ أيام فى المجموعة الضابطة.

لقد وجدنا أن استخدام TXA كان فعالاً فى تقليل النزيف الجراحى وحجم نقل الدم بعد العملية الجراحية للمرضى الذين يخضعون لعمليات جراحية لتشوه العمود الفقرى. ومع ذلك، لم يكن هناك تأثير ذو دلالة إحصائية لـ TXA على النتيجة السريرية الشاملة.