International Journal of Research and Review
[Indexed, Peer-Reviewed Journal]
Volume 13; Issue: 6; June 2026
Website: www.ijrrjournal.com
Research Paper *E-ISSN: 2349-9788; P-ISSN: 2454-2237*

Local Tranexamic Acid During Decompression-Stabilization-Fusion in Lumbar Spinal Canal Stenosis: Effects on Coagulation and Postoperative Drainage

I Made Wira Kusuma[1], I Ketut Suyasa[1], IGN Wien Aryana[1], Made Bramantya Karna[1], IGLNA Artha Wiguna[1], Stedi Adnyana Christian[1],

[1]Department of Orthopaedic and Traumatology, Prof. Ngoerah Hospital, Faculty of Medicine, Udayana University, Bali, Indonesia.

Corresponding Author: I Made Wira Kusuma

DOI: https://doi.org/10.52403/ijrr.20260621

ABSTRACT

Decompression-stabilization-fusion for lumbar spinal canal stenosis is frequently associated with considerable perioperative bleeding. Local tranexamic acid may improve surgical hemostasis while limiting systemic exposure. This study evaluated the effect of local tranexamic acid solution applied for 5 minutes to the operative field on postoperative prothrombin time, activated partial thromboplastin time, 24-hour drain volume, and drain duration in patients undergoing decompression-stabilization-fusion. This quasi-experimental comparative study included 52 patients with lumbar spinal canal stenosis who underwent decompression-stabilization-fusion at RSUP Prof. Dr. I.G.N.G. Ngoerah, Bali, Indonesia. Patients were divided into a local tranexamic acid group (n=26) and a control group without tranexamic acid application (n=26). Postoperative prothrombin time, activated partial thromboplastin time, 24-hour drain volume, and drain duration were compared between groups using the independent t-test or Mann-Whitney U test, with $p<0.05$ considered statistically significant. Postoperative prothrombin time did not differ significantly between the control and tranexamic acid groups (median 10.10 [9.70-14.90] vs. 10.55 [9.90-12.10] seconds; $p=0.240$). Activated partial thromboplastin time was also comparable between groups (median 25.80 [12.10-35.90] vs. 25.45 [18.50-29.70] seconds; $p=0.869$). The tranexamic acid group had significantly lower 24-hour drain volume than the control group (168.46±39.86 vs. 251.00±59.70 mL; $p<0.001$) and shorter drain duration (median 2.00 [2.00-3.00] vs. 4.00 [3.00-7.00] days; $p<0.001$). Local tranexamic acid application reduced postoperative drainage and shortened drain use without significantly altering postoperative prothrombin time or activated partial thromboplastin time.

Keywords: Tranexamic acid; lumbar spinal canal stenosis; decompression-stabilization-fusion; prothrombin time; activated partial thromboplastin time; postoperative drainage.

INTRODUCTION

Lumbar spinal canal stenosis is one of the most common degenerative spinal disorders in older adults and is characterized by narrowing of the lumbar spinal canal, lateral recess, or intervertebral foramina, resulting

in compression of neural and vascular structures. The disease commonly presents with neurogenic claudication, radicular leg pain, back pain, impaired walking capacity, and functional limitation.[1-3] Population-based evidence from the Framingham Study showed that radiographic lumbar spinal stenosis is common in the aging population and is associated with low back pain, supporting its importance as a major degenerative spine condition.[4] Surgical decompression remains an important treatment option for selected patients with persistent symptoms, functional limitation, and radiological stenosis who fail to respond adequately to conservative treatment.[5-7]

Decompression-stabilization-fusion is frequently performed in lumbar spinal canal stenosis when decompression alone is considered insufficient, particularly in patients with instability, degenerative spondylolisthesis, deformity, or multilevel degenerative disease.[8] Although this procedure can improve neural decompression and mechanical stability, it is often associated with substantial intraoperative and postoperative blood loss because of extensive paraspinal muscle dissection, epidural venous plexus bleeding, decortication of posterior bony elements, and exposure of cancellous bone surfaces.[9,10] Excessive perioperative bleeding may increase the risk of postoperative anemia, transfusion, wound complications, surgical site infection, delayed mobilization, prolonged rehabilitation, and longer hospital stay.[9,10] Therefore, effective perioperative blood management is a clinically important component of decompression-stabilization-fusion surgery.

Tranexamic acid is a synthetic antifibrinolytic agent that reduces bleeding by reversibly blocking lysine-binding sites on plasminogen, thereby inhibiting plasminogen activation and fibrin degradation. [11,12] Tranexamic acid has been widely used in orthopedic and spine surgery, and previous evidence has shown that antifibrinolytic therapy can reduce surgical blood loss and transfusion requirements across orthopedic procedures.[13-15] In spine surgery, tranexamic acid has been evaluated through intravenous, topical, and combined routes, with meta-analyses suggesting beneficial effects on perioperative blood loss and drainage-related outcomes.[16-19]

Intravenous tranexamic acid is commonly used because of its predictable systemic antifibrinolytic effect. However, systemic administration may raise concerns in selected patients with thromboembolic risk, severe ischemic heart disease, renal impairment, or other high-risk comorbidities, even though major complications are uncommon in most orthopedic populations.[20-22] Local or topical tranexamic acid application has therefore gained interest because it can deliver a high antifibrinolytic concentration directly to the bleeding surgical surface while theoretically limiting systemic exposure.[17,23,24] In major orthopedic procedures such as total hip and knee arthroplasty, topical tranexamic acid has been shown to reduce blood loss and transfusion requirements, supporting its biological plausibility and clinical utility as a local hemostatic adjunct.[23-25]

Evidence regarding topical tranexamic acid in spinal surgery has expanded in recent years. A previous meta-analysis reported that topical tranexamic acid reduced total blood loss and drainage volume in spine surgery.[18] Another meta-analysis found that tranexamic acid administered into the wound reduced postoperative drainage, blood loss, and hospital stay.[19] More recent evidence also supports the efficacy and safety of topical tranexamic acid in spinal surgery, including reductions in postoperative drainage volume, duration of drainage, transfusion rate, and length of stay.[17] Studies in lumbar fusion populations have similarly reported lower postoperative blood loss and earlier drain removal after topical tranexamic acid administration, without clear evidence of increased thromboembolic complications or

clinically meaningful changes in coagulation parameters.[26,27]

Despite these findings, evidence remains limited regarding the effect of standardized 5-minute local tranexamic acid solution application during decompression-stabilization-fusion specifically in patients with lumbar spinal canal stenosis, particularly when postoperative coagulation parameters and drain-related outcomes are evaluated simultaneously. Routine coagulation parameters such as prothrombin time and activated partial thromboplastin time may provide practical perioperative information on whether local tranexamic acid is associated with measurable systemic coagulation changes, while 24-hour drain volume and drain duration reflect clinically relevant postoperative bleeding control. Therefore, this study evaluated the effect of local tranexamic acid solution applied for 5 minutes to the surgical field during decompression-stabilization-fusion in patients with lumbar spinal canal stenosis on postoperative prothrombin time, activated partial thromboplastin time, 24-hour drain volume, and drain duration compared with no local tranexamic acid application.

MATERIALS & METHODS

Study Design and Setting

This quasi-experimental comparative study was conducted at RSUP Prof. Dr. I.G.N.G. Ngoerah, Bali, Indonesia. The study included patients with lumbar spinal canal stenosis who underwent decompression-stabilization-fusion surgery. Surgical procedures were performed in the central operating theatre, and postoperative follow-up was conducted in the inpatient ward. Data collection started in June 2025.

Participants and Sample Size

The study population consisted of patients with lumbar spinal canal stenosis scheduled for decompression-stabilization-fusion. Eligible patients were those aged 35-75 years, diagnosed with lumbar spinal canal stenosis based on clinical assessment and magnetic resonance imaging, had a body mass index of 18.5-24.9 kg/m², underwent decompression-stabilization-fusion involving three or four vertebral segments, and provided informed consent.

Patients were excluded if they had a history of thromboembolic disease, coagulopathy, anemia, malignancy, allergy to tranexamic acid, or current use of anticoagulant or antifibrinolytic therapy. Patients were considered dropouts if they withdrew from the study, did not undergo the planned surgery, or died before outcome assessment was completed.

The sample size was calculated using the formula for comparison of two independent numerical means, with a type I error of 5%, a type II error of 20%, and a power of 80%. Based on a clinically meaningful difference in drain duration of 1.51 days and a pooled standard deviation of 2.12 days from previous literature, the minimum sample size was 24 patients per group.[27] After adding 10% to anticipate dropout, 26 patients were included in each group, resulting in a total sample of 52 patients.

Intervention and Surgical Procedure

Patients were assigned to two groups: a control group that underwent decompression-stabilization-fusion without local tranexamic acid and an intervention group that received local tranexamic acid during surgery. In the intervention group, 2 g tranexamic acid was diluted in 100 mL of 0.9% sodium chloride and applied to the operative field for 5 minutes before wound closure. After 5 minutes, the solution was suctioned, and wound closure was performed using the standard technique. Standard hemostatic procedures were applied in both groups.

Before surgery, all patients underwent physical examination, laboratory testing, and lumbar magnetic resonance imaging. Baseline prothrombin time and activated partial thromboplastin time were recorded. Non-steroidal anti-inflammatory drugs and anticoagulant drugs were discontinued before surgery when clinically applicable

according to perioperative assessment and institutional practice.[28]

Outcome Measures

The outcomes were postoperative prothrombin time, postoperative activated partial thromboplastin time, 24-hour postoperative drain volume, and drain duration. Prothrombin time and activated partial thromboplastin time were measured after surgery to evaluate routine coagulation status. The 24-hour drain volume was recorded in milliliters using a graduated measuring container. Drain duration was defined as the number of days from drain placement until removal. The drain was removed when the drainage volume was less than 50 mL per 24 hours.

Ethical Consideration

This study was approved by the Ethical Review Board of RSUP Prof. Dr. I.G.N.G. Ngoerah. Written informed consent was obtained from all participants before enrollment. Patient data were anonymized before analysis. The ethical approval number should be added before manuscript submission.

Statistical Analysis

Statistical analysis was performed using SPSS version 24.0. Categorical variables were presented as frequency and percentage. Numerical variables were presented as mean±standard deviation when normally distributed or median with minimum-maximum range when not normally distributed. Normality was assessed using the Kolmogorov-Smirnov test.

Between-group comparisons for normally distributed numerical variables were analyzed using the independent t-test, while non-normally distributed variables were analyzed using the Mann-Whitney U test. Categorical variables were analyzed using the chi-square test or Fisher's exact test when appropriate. A p-value of less than 0.05 was considered statistically significant.

RESULT

A total of 52 patients with lumbar spinal canal stenosis were included in the analysis, with 26 patients in the control group and 26 patients in the local TXA group.

Baseline characteristics

The study population consisted of 26 men and 26 women with a mean age of 57.77±11.50 years. The distribution of sex, age group, mean age, number of DSF levels, and preoperative coagulation parameters was comparable between the two groups.

Table 1. Baseline characteristics of patients undergoing decompression-stabilization-fusion

Characteristics	Total (n=52)	Without Local TXA (n=26)	With Local TXA (n=26)	p-value
Gender; n (%)				0.165*
Male	26 (50.00)	16 (61.50)	10 (38.50)	
Female	26 (50.00)	10 (38.50)	16 (61.50)	
Age group; n (%)				1.000*
35-50 years	14 (26.90)	7 (26.90)	7 (26.90)	
51-60 years	14 (26.90)	7 (26.90)	7 (26.90)	
>60 years	24 (46.20)	12 (46.20)	12 (46.20)	
Number of DSF levels; n (%)	3.25 (0.51)	3.31 (0.54)	3.19 (0.49)	
Age (years), median (IQR)	57.77 (11.50)	57.96 (11.32)	57.58 (11.82)	
Preoperative PT; means ± SD	10.89 ± 1.31	11.24 ± 1.68	10.53 ± 0.66	
Preoperative APTT; means ± SD	25.16 ± 4.51	24.62 ± 6.20	25.71 ± 1.53	

DSF: decompression-stabilization-fusion; PT: prothrombin time; APTT: activated partial thromboplastin time.

Postoperative coagulation parameters

Postoperative PT and APTT were not significantly different between the control

and local TXA groups, suggesting that topical TXA did not measurably alter routine systemic coagulation parameters.

Table 2. Postoperative prothrombin time by study group

Patient group	Median (min-max)	p-value
Without Local TXA (n=26)	10.10 (9.70-14.90)	0.240
With Local TXA (n=26)	10.55 (9.90-12.10)	

Table 3. Postoperative activated partial thromboplastin time by study group

Patient group	Median (min-max)	p-value
Without Local TXA (n=26)	25.80 (12.10-35.90)	0.869
With Local TXA (n=26)	25.45 (18.50-29.70)	

Postoperative drain outcomes

Patients who received local TXA had lower 24-hour postoperative drain volume and shorter drain duration than patients in the control group, indicating improved local hemostasis after DSF surgery.

Table 4. Postoperative 24-hour drain volume by study group

Patient group	Mean ± SD	p-value	Mean difference (95% CI)
Without Local TXA (n=26)	251.00 ± 59.70	<0.001	82.53 (54.25-110.82)
With Local TXA (n=26)	168.46 ± 39.86		

Table 5. Postoperative drain duration by study group

Patient group	Median (min-max)	p-value
Without Local TXA (n=26)	4.00 (3.00-7.00)	<0.001
With Local TXA (n=26)	2.00 (2.00-3.00)	

DISCUSSION

This study demonstrated that local tranexamic acid application for 5 minutes during decompression-stabilization-fusion in patients with lumbar spinal canal stenosis significantly reduced 24-hour postoperative drain volume and shortened drain duration. In contrast, postoperative prothrombin time and activated partial thromboplastin time were not significantly different between the local tranexamic acid group and the control group. These findings suggest that local tranexamic acid improved local hemostasis without producing measurable changes in routine systemic coagulation parameters.

The reduction in postoperative drainage is biologically plausible because tranexamic acid acts as an antifibrinolytic agent by reversibly blocking lysine-binding sites on plasminogen, thereby inhibiting plasmin formation and fibrin degradation. [11,12] In decompression-stabilization-fusion surgery, bleeding may arise from cancellous bone surfaces, epidural venous plexuses, and extensive paraspinal muscle dissection. Local application of tranexamic acid may provide a high drug concentration directly at these bleeding surfaces while limiting systemic exposure. This mechanism is particularly relevant in lumbar fusion surgery, in which postoperative bleeding and hidden blood loss remain important clinical problems. [9,10]

The findings of this study are consistent with previous evidence on topical tranexamic acid in spinal surgery. Meta-analyses have shown that topical tranexamic acid can reduce postoperative drainage volume, total blood loss, transfusion rate, drainage duration, and hospital stay in patients undergoing spinal procedures.[17-19] Similar benefits have also been reported in lumbar fusion populations, where topical tranexamic acid reduced postoperative blood loss without clear evidence of increased thromboembolic complications. [26,27] The present study supports these findings in the specific setting of decompression-stabilization-fusion for lumbar spinal canal stenosis.

The absence of significant differences in postoperative prothrombin time and activated partial thromboplastin time is also clinically relevant. These findings support the concept that tranexamic acid mainly affects fibrinolysis rather than directly accelerating the intrinsic or extrinsic coagulation pathways. [11,12] Therefore, local tranexamic acid may reduce postoperative bleeding without shortening routine coagulation times. This finding is important because systemic tranexamic acid may raise concerns in selected patients with thromboembolic risk, renal impairment, or other high-risk conditions, although large orthopedic studies have generally shown a favorable safety profile. [20,21]

However, stable prothrombin time and activated partial thromboplastin time should not be interpreted as definitive evidence of complete thrombotic safety. Routine coagulation tests do not fully assess fibrinolytic activity, clot stability, or postoperative thrombotic risk. More comprehensive parameters such as fibrinogen, D-dimer, thromboelastography, or rotational thromboelastometry may provide a more detailed assessment of hemostatic balance in future studies.[22]

The shorter drain duration in the local tranexamic acid group may also have practical postoperative implications. Earlier drain removal may reduce patient discomfort, facilitate mobilization, simplify wound care, and potentially reduce the risk of drain-related contamination. Nevertheless, this study did not directly evaluate surgical site infection, time to mobilization, length of hospital stays, pain score, or cost-effectiveness. Therefore, the clinical implications of shorter drain use should be interpreted cautiously.

This study has several limitations. First, the study was conducted in a single center with a relatively small sample size. Second, several clinically important outcomes were not assessed, including intraoperative blood loss, postoperative hemoglobin change, transfusion requirement, wound complications, thromboembolic events, renal outcomes, length of hospital stay, and functional recovery. Third, postoperative bleeding may be influenced by operative duration, surgical extent, number of fused levels, blood pressure control, baseline medication use, and drain management. Future multicenter studies with larger sample sizes and broader efficacy and safety endpoints are needed to confirm the role of local tranexamic acid in decompression-stabilization-fusion surgery.

CONCLUSION

Local tranexamic acid solution applied for 5 minutes to the operative field during decompression-stabilization-fusion in patients with lumbar spinal canal stenosis significantly reduced 24-hour postoperative drain volume and shortened drain duration. The intervention did not significantly alter postoperative prothrombin time or activated partial thromboplastin time compared with no local tranexamic acid application. These findings support local tranexamic acid as a potentially effective adjunct for perioperative bleeding management in decompression-stabilization-fusion surgery, although larger studies with broader clinical and safety outcomes are still required.

Declaration by Authors

Ethical Approval: This study was approved by the Research Ethics Committee, Faculty of Medicine, Universitas Udayana, Denpasar, Indonesia, with ethical clearance number 1389/UN14.2.2.VII.14/LT/2025 and protocol number 2025.02.1.0560. The ethical approval was issued on 19 May 2025. The study was conducted in accordance with the principles of the International Conference on Harmonisation - Good Clinical Practice and applicable ethical standards for research involving human participants. Written informed consent was obtained from all participants before enrollment, and all patient data were anonymized before analysis to maintain confidentiality.

Acknowledgement: None

Source of Funding: None

Conflict of Interest: No conflicts of interest declared.

REFERENCES

1. Abou-Al-Shaar H, Adogwa O, Mehta AI. Lumbar spinal canal stenosis: objective measurement scales and ambulatory status.

Asian Spine J. 2018;12(4):765-774. doi:10.31616/asj.2018.12.4.765.
2. Bagley C, MacAllister M, Dosselman L, Moreno J, Aoun SG, El Ahmadieh TY. Current concepts and recent advances in understanding and managing lumbar spine stenosis. F1000Res. 2019; 8:137. doi:10.12688/f1000research.16082.1.
3. Benoist M. The natural history of lumbar degenerative spinal stenosis. Joint Bone Spine. 2002;69(5):450-457. doi:10.1016/S1297-319X (02)00429-3.
4. Kalichman L, Cole R, Kim DH, Li L, Suri P, Guermazi A, et al. Spinal stenosis prevalence and association with symptoms: the Framingham Study. Spine J. 2009;9(7):545-550. doi: 10.1016/j.spinee.2009.03.005.
5. Siebert E, Prüss H, Klingebiel R, Failli V, Einhäupl KM, Schwab JM. Lumbar spinal stenosis: syndrome, diagnostics and treatment. Nat Rev Neurol. 2009;5(7):392-403. doi:10.1038/nrneurol.2009.90.
6. Covaro A, Vilà-Canet G, de Frutos AG, Ubierna MT, Ciccolo F, Caceres E. Management of degenerative lumbar spinal stenosis: an evidence-based review. EFORT Open Rev. 2016;1(7):267-274. doi:10.1302/2058-5241.1.000030.
7. Kreiner DS, Shaffer WO, Baisden JL, Gilbert TJ, Summers JT, Toton JF, et al. An evidence-based clinical guideline for the diagnosis and treatment of degenerative lumbar spinal stenosis: update. Spine J. 2013;13(7):734-743. doi: 10.1016/j.spinee.2012.11.059.
8. Lurie J, Tomkins-Lane C. Management of lumbar spinal stenosis. BMJ. 2016;352:h6234. doi:10.1136/bmj.h6234.
9. Bydon M, Alvi MA, Goyal A. Degenerative lumbar spondylolisthesis. Neurosurg Clin N Am. 2019;30(3):299-304. doi: 10.1016/j.nec.2019.02.004.
10. Elgafy H, Bransford RJ, McGuire RA, Dettori JR, Fischer D. Blood loss in major spine surgery: are there effective measures to decrease massive hemorrhage in major spine fusion surgery? Spine (Phila Pa 1976). 2010;35(9 Suppl):S47-S56. doi:10.1097/BRS.0b013e3181d833f6.
11. Smorgick Y, Baker KC, Bachison CC, Herkowitz HN, Montgomery DM, Fischgrund JS. Hidden blood loss during posterior spine fusion surgery. Spine J. 2013;13(8):877-881. doi: 10.1016/j.spinee.2013.02.008.
12. McCormack PL. Tranexamic acid: a review of its use in the treatment of hyperfibrinolysis. Drugs. 2012;72(5):585-617. doi:10.2165/11209070-000000000-00000.
13. Ker K, Edwards P, Perel P, Shakur H, Roberts I. Effect of tranexamic acid on surgical bleeding: systematic review and cumulative meta-analysis. BMJ. 2012;344: e3054. doi:10.1136/bmj. e3054.
14. Kagoma YK, Crowther MA, Douketis J, Bhandari M, Eikelboom J, Lim W. Use of antifibrinolytic therapy to reduce transfusion in patients undergoing orthopedic surgery: a systematic review of randomized trials. Thromb Res. 2009;123(5):687-696. doi: 10.1016/j.thromres.2008.09.015.
15. Davey JR, Kim C, Park SS. Tranexamic acid for the prevention and management of orthopedic surgical hemorrhage: current evidence. J Blood Med. 2015; 6:239-244. doi:10.2147/JBM.S61915.
16. Zhang F, Wang K, Li FN, Huang X, Li Q, Chen Z, et al. Effectiveness of tranexamic acid in reducing blood loss in spinal surgery: a meta-analysis. BMC Musculoskelet Disord. 2014; 15:448. doi:10.1186/1471-2474-15-448.
17. Guo T, Xuan W, Feng H, Wang J, Ma X. The efficacy and safety of topical tranexamic acid for spinal surgery. Curr Pharm Des. 2021;27(44):4496-4503. doi:10.2174/1381612827666210713160016.
18. Luo W, Sun RX, Jiang H, Ma XL. The efficacy and safety of topical administration of tranexamic acid in spine surgery: a meta-analysis. J Orthop Surg Res. 2018;13(1):96. doi:10.1186/s13018-018-0815-0.
19. Hui S, Peng Y, Tao L, Wang S, Yang Y, Du Y, et al. Tranexamic acid given into wound reduces postoperative drainage, blood loss, and hospital stay in spinal surgeries: a meta-analysis. J Orthop Surg Res. 2021;16(1):401. doi:10.1186/s13018-021-02548-6.
20. Luo H, Zhang X, Xie C, Wu L, Cai G, Ren Y. Efficacy and safety of topical tranexamic acid in spinal surgery: a systematic review and meta-analysis. EFORT Open Rev. 2024;9(8):796-805. doi:10.1530/EOR-23-0199.
21. Fillingham YA, Ramkumar DB, Jevsevar DS, Yates AJ Jr, Bini SA, Clarke HD, et al.

Tranexamic acid in total joint arthroplasty: the endorsed clinical practice guides of the American Association of Hip and Knee Surgeons, American Society of Regional Anesthesia and Pain Medicine, American Academy of Orthopaedic Surgeons, Hip Society, and Knee Society. Reg Anesth Pain Med. 2019;44(1):7-11. doi:10.1136/rapm-2018-000024.

22. Poeran J, Rasul R, Suzuki S, Danninger T, Mazumdar M, Opperer M, et al. Tranexamic acid use and postoperative outcomes in patients undergoing total hip or knee arthroplasty in the United States: retrospective analysis of effectiveness and safety. BMJ. 2014;349:g4829. doi:10.1136/bmj.g4829.
23. Schutgens REG, Lisman T. Tranexamic acid is not a universal hemostatic agent. HemaSphere. 2021;5(8):e625. doi:10.1097/HS9.0000000000000625.
24. Alshryda S, Mason J, Sarda P, Nargol A, Cooke N, Ahmad H, et al. Topical intra-articular tranexamic acid reduces blood loss and transfusion rates following total hip replacement: a randomized controlled trial. J Bone Joint Surg Am. 2013;95(21):1969-1974. doi:10.2106/JBJS.L.00908.
25. Gomez-Barrena E, Ortega-Andreu M, Padilla-Eguiluz NG, Pérez-Chrzanowska H, Figueredo-Zalve R. Topical intra-articular compared with intravenous tranexamic acid to reduce blood loss in primary total knee replacement: a double-blind, randomized, controlled, noninferiority clinical trial. J Bone Joint Surg Am. 2014;96(23):1937-1944. doi:10.2106/JBJS.N.00060.
26. Yang ZG, Chen WP, Wu LD. Effectiveness and safety of tranexamic acid in reducing blood loss in total knee arthroplasty: a meta-analysis. J Bone Joint Surg Am. 2012;94(13):1153-1159. doi:10.2106/JBJS.K.00873.
27. Xu D, Chen X, Li Z, Ren Z, Zhuang Q, Li S. Tranexamic acid reduce hidden blood loss in posterior lumbar interbody fusion (PLIF) surgery. Medicine (Baltimore). 2020;99(11):e19552. doi:10.1097/MD.0000000000019552.
28. Shi P, Wang J, Cai T, Chen D, Wang S, Feng X, et al. Safety and efficacy of topical administration of tranexamic acid in high-risk patients undergoing posterior lumbar interbody fusion surgery. World Neurosurg. 2021;149: e488-e495. doi: 10.1016/j.wneu.2021.04.088.
29. Jongkittanakul S, Tanaviriyachai T, Choovongkomol K, Piyapromdee U, Sudprasert W. Application of topical tranexamic acid reduces postoperative blood loss after posterior spinal fusion with instrumentation in patients with adolescent idiopathic scoliosis. J Southeast Asian Orthop. 2023;47(1):38-45. doi:10.56929/jseaortho-022-0164.
30. Sudprasert W, Tanaviriyachai T, Choovongkomol K, Jongkittanakul S, Piyapromdee U. A randomized controlled trial of topical application of tranexamic acid in patients with thoracolumbar spine trauma undergoing long-segment instrumented posterior spinal fusion. Asian Spine J. 2019;13(1):146-154. doi:10.31616/asj.2018.0125.
31. Shakur H, Roberts I, Bautista R, Caballero J, Coats T, Dewan Y, et al. Effects of tranexamic acid on death, vascular occlusive events, and blood transfusion in trauma patients with significant haemorrhage (CRASH-2): a randomised, placebo-controlled trial. Lancet. 2010;376(9734):23-32. doi:10.1016/S0140-6736(10)60835-5.
32. Roberts I, Shakur H, Coats T, Hunt B, Balogun E, Barnetson L, et al. The CRASH-2 trial: a randomised controlled trial and economic evaluation of the effects of tranexamic acid on death, vascular occlusive events and transfusion requirement in bleeding trauma patients. Health Technol Assess. 2013;17(10):1-79. doi:10.3310/hta17100.
33. Younan M, Atkinson TJ, Fudin J. A practical approach to discontinuing NSAID therapy prior to a procedure. Pract Pain Manag. 2013;13(10):45-51.

How to cite this article: I Made Wira Kusuma, I Ketut Suyasa, IGN Wien Aryana, Made Bramantya Karna, IGLNA Artha Wiguna, Stedi Adnyana Christian. Local tranexamic acid during decompression-stabilization-fusion in lumbar spinal canal stenosis: effects on coagulation and postoperative drainage. *International Journal of Research and Review*. 2026; 13(6): 211-218. DOI: *https://doi.org/10.52403/ijrr.20260621*

******