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Review Article

Tranexamic Acid for the Management of Hematuria: A Systematic Review

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A B S T R A C T

Objective: To evaluate tranexamic acid (TXA)'s efficacy in managing hematuria and synthesize current evidence to guide urological practice.
Methods: This systematic review followed Preferred Reporting Items for Systematic Reviews and Meta-Analyse 2020 guidelines and was registered in PROSPERO (CRD42022335404). We searched four databases, including PubMed, EMBASE, CINAHL, and Cochrane, for studies on TXA use in adults with hematuria with either interventional or observational designs. Data extraction and quality assessment were performed independently by 2 reviewers, and findings were summarized using a narrative synthesis.
Results: The search yielded 227 records, of which seven studies (970 participants) met inclusion criteria. Four trials on postoperative hematuria showed that TXA—particularly intravenous—consistently reduced hemoglobin decline and blood loss. Three studies on non-postoperative hematuria demonstrated reductions in visible hematuria and symptom duration, though effects on transfusion and laboratory outcomes were variable. All administration routes—intravenous, oral, and intravesical irrigation—were effective; however, IV TXA showed superior outcomes in postoperative cases, while oral and irrigation routes appeared more advantageous in non-surgical settings.
Conclusion: TXA is effective in reducing both postoperative and non-postoperative hematuria, supporting its expanded use in urological practice. However, larger, high-quality studies are needed to confirm these findings and refine treatment protocols.

Tranexamic acid (TXA) is a synthetic lysine analog classified as an antifibrinolytic agent. It competitively inhibits the activation of plasminogen to plasmin, a serine protease responsible for fibrin degradation, thereby stabilizing fibrin clots and reducing bleeding.[1] Its action opposes fibrinolytic agents, such as alteplase and urokinase, which promote clot dissolution.[2] The use of antifibrinolytics has expanded to populations receiving anticoagulants or other coagulation-modifying therapies, with evidence suggesting that TXA does not significantly increase the risk of thromboembolic events in these populations.[3] Over the past decades, TXA has been widely used to manage and prevent bleeding across diverse clinical settings. Its efficacy has been established across a range of hemorrhagic conditions, including postpartum hemorrhage, menorrhagia, hemoptysis, epistaxis, hematological disorders, trauma-related bleeding, dental procedures, cardiothoracic, facial aesthetic, and orthopedic surgeries, among others.[4–11] Depending on the clinical scenario, TXA can be administered orally, intravenously, or topically (including mucosal or intraoperative irrigation). TXA is generally well tolerated; common adverse events include nausea, vomiting, diarrhea, and hypotension with rapid intravenous administration.[12] Despite decades of use and substantial supporting evidence, hesitancy regarding the use of TXA persists in several specialties, including urology.

In urology, TXA has been historically approached with caution due to several concerns, primarily the perceived risk of thromboembolic events, yet it has never been subject to formal contraindication. Intriguingly, this concern has been increasingly challenged by a growing body of evidence demonstrating no significant increase in thrombosis risk among medical or surgical patients receiving TXA.[3,13–15] Additionally, there are urology-specific concerns, particularly the potential for acute kidney injury in patients with hematuria—especially when originating from upper urinary tract sources such as the renal parenchyma.[16] Since TXA is primarily excreted in the urine, its use in these cases may increase the risk of clot retention and subsequent urinary tract obstruction.[15] This has led to warnings or relative contraindications in certain contexts—for instance, in Canada, TXA is contraindicated in cases of hematuria secondary to renal parenchymal disease.[16]

It should be noted, however, that this hypothesis is largely derived from case reports, and hence there is a growing belief that the rationale behind current recommendations is weak and lacks robust clinical validation.[17,18] Notably, a case report and a case series involving eight patients suggested that TXA may actually help preserve kidney function by controlling hematuria in individuals with polycystic kidney disease and chronic kidney impairment, without any reported incidence of thromboembolism or acute kidney injury.[19,20] Likewise, a safety-focused systematic review published in 2022, which included 3 randomized controlled trials (RCTs) and 3 cohort studies, found that medical and surgical patients with hematuria who received TXA did not

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experience any worsening of renal function.[21] Current data, though limited and of modest quality, do not demonstrate an increased risk of renal impairment with TXA in this population. With the growing recognition of its safety, the use of TXA in urological settings has expanded in recent years, albeit largely extrapolated from other clinical contexts due to the paucity of urology-specific data. To address this gap, the present systematic review aims to evaluate the efficacy of TXA, administered via various routes, in the management of hematuria, with the goal of synthesizing current evidence on clinical outcomes to better inform and guide evidence-based practice in urological care.

METHODS

This systematic review adheres to the guidelines outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement.[22] The review protocol was prospectively registered in the International Prospective Register of Systematic Reviews (PROSPERO) under the reference number CRD42022335404.

Literature Search Strategy

A comprehensive search was conducted across the following electronic databases: PubMed, EMBASE, CINAHL, and the Cochrane Database of Systematic Reviews. Keywords and medical subject headings used in the search comprised 2 categories: hematuria, with terms "Hematuria [MeSH]" and "Haematuria"; and tranexamic acid, with terms "Tranexamic acid," "TXA," "cyklokapron," and "lysteda." These keywords were combined using Boolean operators “OR” and “AND.” Search terms were slightly adapted to suit the indexing and search functionality of each database.

The reference lists of all included studies and relevant review articles identified during the search were manually screened to identify any additional eligible publications. Additionally, Google Scholar was used to capture gray literature not indexed in the main databases, with the first 20 pages screened for eligibility. No restrictions were applied to language, publication date, or study design during the search.

Eligibility Criteria

Studies were included if they met the following criteria: (1) involved participants with hematuria regardless of the underlying cause; (2) compared TXA to placebo or standard care without TXA; (3) included adult patients; (4) employed any study design with quantitative outcomes, including interventional studies, such as RCTs and quasi-experimental studies, and observational studies, including prospective and retrospective cohorts; and (5) reported clinical efficacy outcomes related to hematuria management, such as reduction in bleeding, duration of hematuria, or recurrence.

Exclusion criteria comprised case reports, expert opinions, systematic reviews, letters to editors, commentaries, correspondences, news articles, qualitative studies, and conference abstracts without full-text availability. Studies focusing exclusively on pediatric populations were also excluded.

Selection Process

The articles obtained from the database search were imported into Rayyan, an online platform designed for systematic reviews, to detect and remove duplicate records. Screening was conducted in two sequential steps, with titles and abstracts independently reviewed by two reviewers (D.N. and R.A.), followed by independent full-text assessment by the same reviewers, and any disagreements resolved through discussion with a third reviewer (L.N.).

Data Extraction

A tailored data extraction tool was developed and piloted to address the specific requirements of this review. It captured key study details (author, year, country, study design), patient characteristics (total number of patients, number exposed to TXA, age, sex, use of antiplatelet/anticoagulant medications), TXA intervention (dose, route, frequency, and duration), and hematuria information (surgery type or underlying cause, outcome measures, effect estimates such as ORs, CIs, and *P* values). Two reviewers independently extracted data to ensure accuracy.

Evidence Synthesis Strategy

A narrative synthesis was conducted to summarize findings across included studies. Studies were grouped based on the outcomes they reported—for example, those evaluating the duration of hematuria were described together. Results were presented using summary tables alongside the narrative synthesis to clearly display study characteristics, intervention details, and outcome data. Although a meta-analysis was planned, it was not conducted due to high heterogeneity in outcome measures and study variables.

Quality Assessment

Quality assessment was conducted using tools appropriate to the study design. RCTs were evaluated with the MethodologicAl STandards for Epidemiological Research scale, which provides a comprehensive framework for assessing methodological quality across analytic designs (Table S1).[23] Retrospective cohort studies were assessed using the National Heart, Lung, and Blood Institute quality assessment tool for observational cohort and cross-sectional studies (Table S2), which focuses on key elements affecting internal validity such as selection bias, confounding, and outcome assessment. The National Heart, Lung, and Blood Institute tool is publicly available at: https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools.

RESULTS

Study Selection Process

Figure 1 presents the PRISMA flow diagram outlining the study selection process. The initial systematic database search across PubMed, Embase, Cochrane, and CINAHL yielding a total of 227 studies (Figure 1). Duplicates removal was conducted using EndNote and Rayyan, eliminating 30 duplicates and resulting in 197 unique records for title and abstract screening, based on the predefined inclusion and exclusion criteria. From these, a total of 19 articles were selected for full-text screening; however, 4 were excluded due to lack of full text. Of the remaining 15 articles, 8 were excluded for the following reasons: abstract only ($n = 4$) and absence of outcome of interest ($n = 4$). Therefore, 7 articles were included in this systematic review.

Study Characteristics and Participants' Demographics

Table 1 provides a comprehensive summary of the characteristics of the included studies. A total of 7 articles were included, collectively reporting data on 970 participants from five different countries: Iran, India, Italy, Korea, and China. Iran[24,25] and India[26,27] each contributed 2 studies, while the remaining countries contributed one study each. The vast majority of participants were male, a pattern accentuated by the inclusion of 2 studies on transrectal ultrasound-guided prostate biopsy (TRUSBx), a procedure performed exclusively in men.[27,28] All included articles were published in English between 2016 and 2024. The cause of hematuria across studies could be broadly categorized into postoperative and non-postoperative hematuria. Operations included

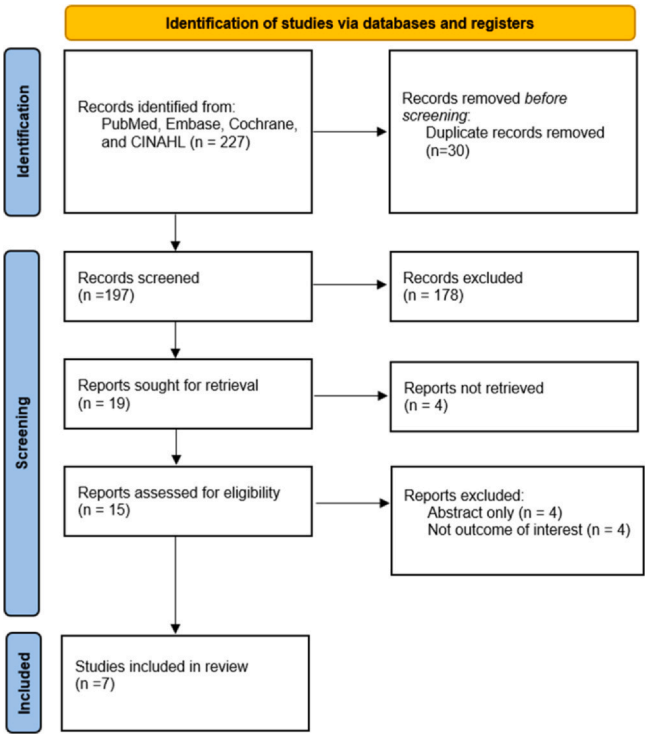

Figure 1. PRISMA flow diagram illustrating the study selection process.

TRUSBx[27,28] and percutaneous nephrolithotomy (PCNL),[24,26] both of which are well-established causes of post-surgical hematuria. Among non-post-operative cases, the most common presentation involved patients visiting the emergency department with hematuria for undetermined origin.[25,29] Additionally, one article only focused specifically on hematuria secondary to autosomal dominant polycystic kidney disease (ADPKD).[30]

TXA Use for Postoperative Hematuria

Table 2 presents a consolidated summary of findings from four RCTs evaluating the efficacy of TXA compared to various control interventions in managing postoperative hematuria. The included studies exhibited considerable heterogeneity in their methodologies, particularly the route and dosage of TXA administration, the hematuria measurement methods, and the time points for outcome assessment. Three of the four included studies quantified hematuria by assessing changes in blood parameters such as hematocrit, hemoglobin, or total blood loss.[24,26,27] Kundargi et al (2024) investigated both intravenous (IV) and intraoperative irrigation routes for TXA administration, concluding that both methods significantly reduced postoperative drops in hemoglobin and hematocrit at 4 and 24 hours compared to the control group. Notably, the IV route was associated with a consistently smaller reduction than irrigation. At 4 h, the mean hemoglobin drop was significantly lower with IV administration (0.274 vs. 0.511 g/dL, p = 0.022), as was the hematocrit drop (0.625% vs. 0.725%, $P = .020$). This trend persisted at 24 hours, with a lower hemoglobin reduction in the IV group (0.811 vs 0.828 g/dL, $P = .009$), although the hematocrit drop was slightly lower in the irrigation group (0.911% vs 0.948%, $P < .001$).[31] Supporting these findings, Mokhtari et al (2021) observed a mean hemoglobin drop of only 0.99 g/dL in the TXA group, which received an initial 1 g IV dose followed by 5 mg orally, markedly less than the 2.27 g/dL decrease seen in the control group ($P < .001$).[24] Similarly, Singh and Khatri (2023), using IV administration of TXA, observed a smaller mean hemoglobin drop in the TXA group (0.45 g/dL) compared to the control group (1.00 g/dL; p = 0.001).[26] Additionally, they quantified total blood loss, reporting significantly lower volumes in patients receiving IV TXA (73.80 ± 60.1 ml) compared to the control group (117.24 ± 87.9 ml), a difference deemed both clinically and statistically significant.[26] Unlike the other trials, which assessed hematuria primarily through blood parameter changes shortly after surgery, Dell'Atti et al (2016) evaluated hematuria incidence over a 14- to 18-day follow-up period. They found that oral TXA reduced the incidence of hematuria to only 10.7%, compared to 18.8% in the control group, a relative reduction of approximately 43% ($P < .001$).[28] Overall, despite methodological variability, intravenous TXA consistently demonstrated superior efficacy in minimizing hemoglobin decline and perioperative blood loss compared to irrigation or oral administration. Nonetheless, all routes demonstrated significant therapeutic benefit in mitigating both the magnitude and incidence of postoperative hematuria.

TXA Use for Other Causes of Hematuria

Table 3 compiles studies that investigated the use of TXA in treating hematuria secondary to various non-postoperative causes.[25,29,30] Among these, 2 studies evaluated local irrigation of TXA for patients presenting to the emergency department with hematuria.[25,29] Although both studies used a catheter clamping duration of 15 minutes, they differed in TXA dosage. Choi et al (2023) examined four outcomes, including length of hospital stay, duration of Foley catheter, hospital revisits, and hospital admission, with hospital admission being the only outcome with no statistically significant difference, exhibiting a P value of 0.052.[29] Similarly, Moharamzadeh et al (2017) reported both statistically significant and non-significant findings.[23] Notably, both the volume of irrigation fluid and the amount of visible blood in urine at 24 hours were significantly reduced in the TXA group compared to controls, with a P value of .041 and .026, respectively. However, no significance differences were found in hemoglobin levels at 6 and 24 hours, transfusion rates, or microscopic hematuria at 1 and 3 hours.[25] Lastly, Yao et al (2017) investigated IV TXA in the patients presenting with hematuria secondary to cyst hemorrhage in ADPKD.[30] TXA use significantly reduced hematuria duration with a mean of 4 days in the TXA group compared to the 7 days in the control group

Table 1
Studies characteristics and participants' demographics.

Article	Article Type	Country	Sample Size	Male (%)	Age (Median/ Mean)	Cause of Hematuria
Dell'Atti et al, 2016[6]	RCT	Italy	359	100.0	64.2	Post-TRUSBx
Moharamzadeh et al, 2017[4]	RCT	Iran	50	86.0	62.6	Presenting to ED with hematuria
Mokhtari et al, 2021[5]	RCT	Iran	108	52.0*	39.5*	Post-PCNL
Singh and khatri, 2023[3]	RCT	India	150	-	41.0*	Post-PCNL
Kundargi et al, 2024[9]	RCT	India	105	100.0	69.0*	Post-TRUSBx
Yao et al, 2017[7]	Retrospective cohort	China	40	58.0	49.0	Cyst hemorrhage in ADPKD
Choi et al, 2023[8]	Retrospective cohort	Korea	159	97.0	78.4	Presenting to ED with hematuria

ADPKD, autosomal dominant polycystic kidney disease; ED, emergency department; PCNL, percutaneous nephrolithotomy; RCT, randomized controlled trial; TRUSBx, transrectal ultrasound-guided prostate biopsy.

* Sex/age for the intervention group only as the total numbers were not reported.

Table 2
Syntheses that include TXA use for operative causes of hematuria.

	Article	Use of Antiplatelet or Anticoagulants	Dosage	Route	Frequency	Duration	Type of Operation	Aims	
1	Kundargi et al, 2024[2]	Excluded	Irrigation: 500 mg of TXA in each bottle of 3,000 ml 0.9% normal saline till a maximum of 2 g) IV: 1 g	IV and irrigation	IV group: once preoperativeIrrigation: intraoperative	Not Mentioned	Bipolar-TRUP	ΔHb (g/dl) after 4 hours	Significant reduction with TXA (P = .022)
								ΔHb (g/dl) after day 1	Significant reduction with TXA (P = .009)
								ΔHCT (%)after 4 hours	Significant reduction with TXA (P = .020)
								ΔHCT (%)after day 1	Significant reduction with TXA (P = < .001)
2	Dell'Atti et al, 2016[6]	All participants	250 mg tabs x 2	Oral	once 1 hour before the procedure	Single-dose (short-term use)	TRUSBx	Incidence of hematuria (%)	Significant reduction with TXA (P = < .001)
3	Mokhtari et al, 2021[5]	Not mentioned	IV:1gr at the beginning then 5 mg orally	IV then Oral	IV: once then orally: every 8 hours for 3 days	Orally for 3 days	PCNL	Hb (Mean ± SD) at 48 hours after surgery	Significant reduction with TXA (P = < .001)
	Singh and khatri, 2023[3]	Not mentioned	1 gm (10 cc) of TXA	IV	Once 20 minutes before the procedure	Not mentioned	PCNL	Total blood loss, ml (Mean ± SD)ΔHb, g/dl (Mean ± SD)	Both TXA and control groups had statistically and clinically significant blood loss Significant reduction with TXA (P = .001)

IV, intravenous; PCNL, percutaneous nephrolithotomy; SD, standard deviation; TURP, transurethral resection of the prostate; TXA, tranexamic acid; ΔHb, mean drop in hemoglobin; ΔHCT, mean drop in hematocrit.

(P value = < 0.001). Furthermore, the levels of D-dimer and fibrinogen degradation products in the TXA group were reduced significantly (P value = < .001). In contrast, there were no statistically significant differences between the two groups in terms of treatment failure, blood transfusion rate, and blood transfusion volume with P values of .60, .29, and .12, respectively. Overall, TXA showed promise in reducing visible hematuria and certain laboratory markers across all three studies.

DISCUSSION

This systematic review demonstrates that TXA is effective in reducing hematuria duration, visible bleeding, and hemoglobin decline across both postoperative and non-postoperative settings. TXA was administered through various routes—IV, oral, and local irrigation—all of which demonstrated clinical benefit. IV administration was most frequently associated with rapid and measurable reductions in blood loss and hemoglobin decline, while oral and irrigation routes also showed favorable outcomes, particularly in non-surgical and emergency settings.

In line with previous studies in other surgical settings,[4–11,32] TXA demonstrated a significant effect in controlling hematuria in urological patients, whether postoperative or due to non-surgical causes. Its benefits were observed across a variety of clinical contexts, including procedures such as transrectal prostate biopsy and PCNL, as well as emergency presentations and hematuria related to chronic kidney disease or polycystic kidney disease. Additionally, a recently published safety-focused systematic review showed no significant increase in adverse events such as thromboembolism or renal complications.[21] This further supports the notion that TXA could be more broadly considered as a therapeutic option in urology.

Although all routes of TXA acid administration—intravenous (IV), oral, and intravesical irrigation—have been reported as effective in controlling hematuria, IV therapy occasionally demonstrated superior outcomes in postoperative cases.[24,26,28,31] In contrast, oral and irrigation routes appeared particularly effective in non-surgical settings. These findings should be interpreted cautiously, given limitations in outcome reporting that hinder direct comparisons across administration routes. This observation aligns with a previous randomized, double-blind, controlled trial in patients undergoing primary hip arthroplasty, which reported effectiveness with all three routes.[33] Similarly, a prospective cohort study showed that oral and IV TXA have comparable blood-sparing properties in patients undergoing staggered bilateral total knee arthroplasty.[34]

The availability of multiple effective routes highlights TXA's adaptability to different clinical scenarios. IV administration may be favored in situations requiring rapid hemostasis, while the oral route may be more suitable in less urgent settings or for ongoing management due to its cost-effectiveness.[35] Evidence for topical TXA is also encouraging, both in our study population and in other settings such as epistaxis;[36] however, the current evidence remains limited and of low quality. Topical administration is promising because high local concentrations at the bleeding site may enhance efficacy, while low systemic absorption minimizes risks.[12]

This systematic review has several strengths. It was conducted according to the PRISMA 2020 guidelines, with a prospectively registered protocol in PROSPERO, ensuring transparency and minimizing reporting bias. A comprehensive literature search was performed across multiple databases, supplemented by manual screening of references and gray literature, without restrictions on language, publication date, or study design. The review provides a broad perspective by including both postoperative and non-postoperative hematuria and examining multiple routes of TXA administration (IV, oral, and irrigation).

Nonetheless, some limitations should be acknowledged. The small number of included studies, predominantly male populations, and variability in TXA dosing, administration routes, outcome measures, and follow-up periods limit generalizability and precluded meta-

Table 3
Syntheses that include TXA use for non-operative causes of hematuria.

	Article	Use of Antiplatelet or Anticoagulants	Dosage	Route	Frequency	Duration	Cause of Hematuria	Aims	
1	Choi et al (2023)[8]	20 patients on anticoagulants and 69 patients on antiplatelet	1 g diluted with 100 ml of normal saline solution	Local	Not mentioned	Catheter was clamped for 15 minutes after the administration of TXA	In the ED for hematuria	Length of stay	Significant reduction with TXA ($P = < .001$)
								Duration of foley catheter	Significant reduction with TXA ($P = < .001$)
								Hospital revisits	Significant reduction with TXA ($P = .03$)
								Admission to hospital	Nonsignificant difference ($P = .052$)
2	Moharamzadeh et al (2017)[4]	Not mentioned	500 mg diluted with 100 ml of normal saline solution	Local	Not mentioned	Catheter was clamped for 15 minutes after the administration of TXA	In the ED for hematuria or clotting with urination	Amount of irrigation serum	Significant reduction with TXA ($P = .041$)
								Hemoglobin at 6 hours	Nonsignificant difference ($P = .47$)
								Hemoglobin at 24 hours	Nonsignificant difference ($P = .39$)
								Blood transfusion rate	Nonsignificant difference ($P = .08$)
								Amount of blood in urine at 1 hour	Nonsignificant difference ($P = .68$)
								Amount of blood in urine at 3 hours	Nonsignificant difference ($P = .39$)
								Amount of blood in urine at 24 hours	Significant reduction with TXA ($P = .026$)
3	Yao et al (2017)[7]	Excluded	Dose varied (5 or 10 mg/kg) based on kidney function along with snake venom blood clotting enzyme 1000 U	IV	Once or twice daily based on kidney function	Until the resolution of hematuria for 48 hours	Cyst hemorrhage in ADPKD	Hematuria duration	Significant reduction with TXA ($P = < .001$)
								D-dimer and FDP	Significant reduction with TXA ($P = < .001$)
								Treatment failure	Significant reduction with TXA ($P = .60$)
								Blood transfusion rate	Significant reduction with TXA ($P = .29$)
								Blood transfusion volume	Nonsignificant difference ($P = .12$)

analysis. Some studies were single-center or had small sample sizes, and outcomes were reported inconsistently, with limited detail on different measures of hematuria—such as hemoglobin/hematocrit changes, visible hematuria, or duration of bleeding—which often demonstrated statistically significant but not clinically meaningful differences. However, in certain contexts, a single outcome measure may provide adequate clinical information. Additionally, few studies evaluated patient-centered or clinically important outcomes such as transfusion requirements, limiting the ability to draw firm conclusions about real-world benefit.

Therefore, while the findings suggest potential therapeutic value, future research should focus on robust, clinically relevant endpoints and include larger, well-designed trials to determine the optimal route, dose, and duration of TXA across diverse clinical scenarios. Despite these limitations, the review underscores the potential utility and adaptability of TXA, reinforcing the need for high-quality studies to better define its role in clinical practice.

CONCLUSION

TXA, whether given IV, orally, or through local irrigation, appears effective in reducing hematuria in both postoperative and non-postoperative contexts by minimizing hemoglobin decline, blood loss, visible bleeding, and the duration of hematuria compared to controls. However, most reported benefits are based on surrogate markers and may not necessarily translate into clinically meaningful improvements in all contexts. Therefore, while these findings support its wider application in urological care, large-scale, high-quality studies assessing clinically important outcomes—such as transfusion requirements and the need for further intervention—are still required to validate the evidence and optimize treatment protocols.

Ethical Declaration

Not required.

Disclosures

There was no explicit funding for the development of this work.

CRediT Authorship Contribution Statement

Lina Naseralallah: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Dima Nasrallah:** Writing – review & editing, Writing – original draft, Visualization, Validation, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Raneem Alsheikh:** Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Data curation. **Deemah Assami:** Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Investigation, Data curation. **Rawan Boudaka:** Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Data curation.

Availability of data

All data generated or analyzed in this systematic review are included in this article and/or its figures. Further inquiries can be directed to the corresponding author.

Declaration of Competing Interest

No conflict.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.urology.2025.12.035.

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