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Combined Intravenous and Topical Tranexamic Acid Versus Intravenous Administration Alone in Total Knee Arthroplasty: A Comparative Study

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Abstract

Background: Postoperative blood loss remains a major concern in total knee arthroplasty (TKA). Tranexamic acid (TXA) reduces bleeding, yet the optimal route of administration is debated. This study compared combined intravenous (IV) plus topical TXA against IV TXA alone. Methods: A comparative study was conducted in the trauma department of the clinics of the Fergana Medical Institute of Public Health on 72 patients undergoing primary unilateral TKA. Thirty-six patients received combined IV and topical TXA and 36 matched controls received IV TXA alone. Total blood loss, hemoglobin decline, transfusion rate, and thromboembolic events were assessed. Results: The combined group showed significantly lower calculated total blood loss (612 vs 884 mL) and smaller hemoglobin decline at postoperative day three. Transfusion requirement fell from 19.4% to 5.6%. Venous thromboembolism rates did not differ. Conclusion: Combined IV and topical TXA offers superior blood conservation over IV TXA alone without added thrombotic risk.

Keywords: *tranexamic acid; total knee arthroplasty; blood loss; topical administration; intravenous; transfusion; trauma; hemoglobin*

Introduction

Total knee arthroplasty is among the most frequently performed elective orthopedic procedures and is associated with substantial perioperative blood loss, much of which is hidden within the tissues and joint cavity [1]. Excessive bleeding lowers hemoglobin levels, prolongs hospitalization, and increases the likelihood of allogeneic blood transfusion, which itself carries risks of infection, immunomodulation, and increased cost [2], [3]. Effective blood-conservation strategies are therefore central to modern arthroplasty practice.

Tranexamic acid, a synthetic antifibrinolytic agent, has become a cornerstone of blood management in joint replacement surgery. By competitively inhibiting plasminogen activation, it stabilizes formed clots and limits fibrinolysis at the surgical site [4]. Both

intravenous and topical (intra-articular) routes have demonstrated efficacy, but each has theoretical advantages: the intravenous route achieves systemic distribution, whereas topical application delivers high local concentrations with minimal systemic absorption [5], [6]. Comparative trials have generally found the two routes broadly equivalent for blood loss [7], [8].

A growing body of evidence suggests that combining the two routes may provide additive hemostatic benefit by simultaneously addressing systemic and local fibrinolysis. Meta-analyses report that combined administration reduces total blood loss, hemoglobin decline, and transfusion need compared with single-route protocols, without increasing thromboembolic complications [9], [10], [11]. However, data from Central Asian populations and from trauma-department settings remain limited. The present study evaluated whether combined intravenous and topical TXA confers measurable advantages over intravenous administration alone in patients undergoing primary TKA at our institution [12].

Methods

This comparative study was carried out in the trauma department of the clinics of the Fergana Medical Institute of Public Health. Seventy-two adults undergoing primary unilateral TKA for osteoarthritis were enrolled. Thirty-six patients formed the intervention group (combined IV and topical TXA) and 36 matched patients formed the control group (IV TXA alone). Groups were comparable in age, sex, body mass index, and preoperative hemoglobin.

The combined group received 1 g of intravenous TXA before tourniquet inflation and 1.5 g of topical TXA applied to the joint surfaces before capsule closure. The control group received intravenous TXA only at an equivalent systemic dose. All procedures used a standardized medial parapatellar approach, cemented implants, and identical perioperative thromboprophylaxis. Total blood loss was calculated from hemoglobin balance, and transfusion followed a restrictive threshold. Outcomes recorded were calculated total blood loss, hemoglobin decline at postoperative days one and three, transfusion rate, and symptomatic venous thromboembolism. Continuous variables were compared using the t-test and categorical variables using the chi-square test, with significance set at $p < 0.05$. A comparison of the administration approaches is summarized in Table 1.

Table 1. Comparison of tranexamic acid administration approaches in total knee arthroplasty.

Parameter	Combined (IV+Topical)	IV alone (Control)	Topical alone (literature)
Route	IV bolus + intra-articular	IV bolus only	Intra-articular only
Typical dose	1 g IV + 1.5 g topical	1–2 g IV	1.5–3 g topical
Total blood loss	Lowest	Moderate	Moderate
Systemic exposure	Moderate	Highest	Lowest
Transfusion need	Markedly reduced	Reduced	Reduced
VTE risk	Comparable	Comparable	Lowest
Technical demand	Two steps	Single step	Single step

Results

Both groups were well matched at baseline, with mean preoperative hemoglobin near 13.7 g/dL and no significant difference in age or body mass index. Operative time and tourniquet duration were comparable, confirming that the additional topical step did not meaningfully prolong surgery.

Calculated total blood loss was substantially lower in the combined group, averaging 612 mL compared with 884 mL in the IV-alone group, a difference that reached statistical significance. The reduction was mirrored in the hemoglobin trend: at postoperative day three the combined group retained a higher mean hemoglobin (11.3 vs 10.2 g/dL), indicating better blood conservation throughout the early recovery period. These patterns are illustrated in Figure 1.

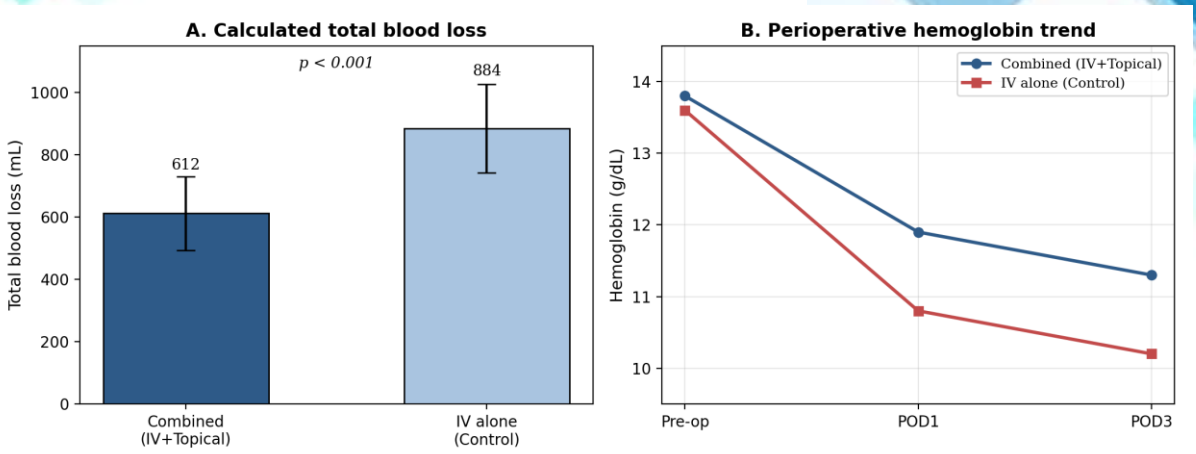

Figure 1. (A) Calculated total blood loss and (B) perioperative hemoglobin trend in the combined and control groups.

Transfusion was required in only 2 of 36 patients (5.6%) in the combined group versus 7 of 36 (19.4%) in the control group. No symptomatic deep vein thrombosis or pulmonary embolism occurred in either group, and wound-related complications were infrequent and evenly distributed. Length of hospital stay trended shorter in the combined group, consistent with reduced anemia and fewer transfusions.

Discussion

The findings of this study support the hypothesis that combining intravenous and topical tranexamic acid provides superior blood conservation in total knee arthroplasty compared with intravenous administration alone. The observed reduction in total blood loss and the preserved hemoglobin levels are consistent with the additive mechanism whereby systemic antifibrinolysis is reinforced by high local drug concentrations at the wound surface [9], [11].

Our transfusion findings align with pooled analyses showing that combined regimens reduce transfusion requirements relative to single-route protocols [10], [14]. Importantly, the absence of thromboembolic events in either group reinforces the established safety profile of TXA, even when two routes are used together; topical application contributes minimally to systemic exposure, which may explain the favorable safety balance [5], [6]. Several randomized trials have likewise reported no increase in venous thromboembolism with combined administration [12], [15].

These results have practical relevance for trauma and arthroplasty units in resource-conscious settings, where reducing transfusion demand carries both clinical and economic benefits [3]. The combined protocol adds only a single intra-articular step and does not prolong surgery appreciably. Limitations include the modest sample size, single-center design, and short follow-up, which preclude assessment of late

complications and functional outcomes [13]. Larger multicenter studies with extended follow-up would help confirm these observations and refine optimal dosing.

Conclusion

Combined intravenous and topical tranexamic acid achieved meaningfully lower blood loss, smaller hemoglobin decline, and fewer transfusions than intravenous administration alone, without any increase in thromboembolic risk. In a busy trauma-department setting, this simple dual-route strategy translates directly into safer recoveries, lighter pressure on blood-bank resources, and a smoother path home for patients undergoing total knee arthroplasty. The approach is inexpensive, technically straightforward, and readily adoptable, making it a compelling default for modern blood management in knee replacement surgery.

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