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Comparative Study for Assessing Blood Loss Post-Operatively in Lower Limb Surgery after Administration of Tranexamic Acid with and Without Tourniquet Use

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Abstract

Background: Post-operative blood loss in lower limb surgeries can lead to complications such as anemia, need for transfusion, and prolonged hospital stays. Tranexamic acid (TXA) is commonly used to reduce blood loss by inhibiting fibrinolysis. The use of a tourniquet during surgery is another technique to control intraoperative bleeding. This study aims to compare post-operative blood loss in patients undergoing lower limb surgery with the administration of TXA, with and without the use of a tourniquet.

Methods: This was a comparative study conducted at a tertiary care hospital. On the basis of inclusion and exclusion criteria 200 patients were included for elective lower limb surgery, divided into four groups (n=50 each): TXA with tourniquet (Group A), TXA without tourniquet (Group B), placebo with tourniquet (Group C), and placebo without tourniquet (Group D).

Intervention: TXA (1 gram intravenously 30 minutes before incision) and tourniquet application (pneumatic, proximal thigh, 100 mmHg above systolic BP). Intraoperative blood loss was recorded, and post-operative blood loss was measured using drain outputs and hemoglobin levels over 48 hours post-surgery.

Results:

Mean Total Blood Loss (mL) in Group A: 350 ± 50, in Group B: 400 ± 60, in Group C: 450 ± 70, and in Group D: 550 ± 80. Mean Hemoglobin level (g/dL) were found to be decrease in all the groups. In Group A: 2.0 ± 0.5, in Group B: 2.5 ± 0.6, in Group C: 3.0 ± 0.7, and in Group D: 3.5 ± 0.8. Blood Transfusion Required (%): Group A: 10%, Group B: 15%, Group C: 20%, Group D: 30%. There was no significant Post-Operative Complications in all groups.

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Conclusion: Both TXA and tourniquet use independently contribute to reducing post-operative blood loss in lower limb surgeries. However, their combined use does not show a significant additive effect. Group A (TXA with tourniquet) showed the least total blood loss and hemoglobin decrease, followed by Group B (TXA without tourniquet), Group C (placebo with tourniquet), and Group D (placebo without tourniquet). The requirement for blood transfusions was highest in the placebo groups, with Group D showing the highest blood loss and hemoglobin decrease. Post-operative complications were minimal and not significantly different among the groups.

Keywords: Anemia, Blood loss, Lower limb surgery, TXA, Tourniquet

Introduction

Lower limb surgeries, including knee and hip replacements, are associated with considerable blood loss, which can complicate recovery and increase morbidity. Tranexamic acid, an antifibrinolytic agent, is effective in reducing blood loss in these surgeries [1,2]. The use of a tourniquet to control intraoperative bleeding is also common practice. However, there is limited evidence on whether the combined use of TXA and a tourniquet provides superior outcomes in terms of reducing post-operative blood loss. This study seeks to address this gap by comparing the effectiveness of TXA alone and in combination with tourniquet use in reducing blood loss after lower limb surgeries.

Methods

This comparative study was conducted at a tertiary care hospital, involving 200 patients scheduled for elective lower limb surgery. The study population was divided into four groups of 50 patients each as follows:

- Group A: TXA with tourniquet
- Group B: TXA without tourniquet
- Group C: Placebo with tourniquet
- Group D: Placebo without tourniquet

Inclusion Criteria and Exclusion Criteria

Adults of age with 18-75 years, Elective lower limb surgery (knee or hip replacement), ASA physical status I-III were included in this study. Patients with History of thromboembolic events, patient with Coagulopathy or anticoagulant therapy and patient with Allergy to TXA were excluded from the study.

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Intervention

TXA was administered at a dose of 1 gram intravenously 30 minutes before the incision. A pneumatic tourniquet was applied at the proximal thigh and inflated to 100 mmHg above systolic blood pressure in the groups designated to use a tourniquet. Intraoperative blood loss was meticulously recorded, and post-operative blood loss was measured using drain outputs and changes in hemoglobin levels over 48 hours post-surgery.

Outcome Measures

- Total blood loss (intraoperative + post-operative)
- Hemoglobin levels pre-operatively and 48 hours post-operatively
- Need for blood transfusion
- Post-operative complications (e.g., deep vein thrombosis, wound healing issues)

Table: 1 Comparative Study for Assessing Blood Loss Post-Operatively in Lower Limb Surgery

Parameter	Group A (TXA + Tourniquet)	Group B (TXA only)	Group C (Placebo + Tourniquet)	Group D (Placebo only)
Number of Patients	50	50	50	50
Mean Total Blood Loss (mL)	350 ± 50	400 ± 60	450 ± 70	550 ± 80
Mean Hemoglobin Decrease (g/dL)	2.0 ± 0.5	2.5 ± 0.6	3.0 ± 0.7	3.5 ± 0.8
Blood Transfusion Required (%)	10	15	20	30
Post-Operative Complications	Minimal, no significant differences across all groups			
Conclusion	Significant blood loss reduction. Least hemoglobin decrease.	Significant blood loss reduction, more than placebo groups.	Moderate blood loss reduction.	Highest blood loss and hemoglobin decrease.

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Table: 2 Lower Limb Surgery Blood Loss Study

Patient ID	Group	Total Blood Loss (mL)	Hb in Pre-Op (g/dL)	Hb in Post-Op (g/dL)	Hemoglobin Decrease (g/dL)	Blood Transfusion Required	Complications
1	TXA + Tourniquet (A)	367	14.6	12.6	2	No	None
2	TXA + Tourniquet (A)	355	14.3	12.4	1.9	No	None
3	TXA + Tourniquet (A)	335	14.9	13	1.9	No	None
4	TXA + Tourniquet (A)	346	14.2	12.2	2	No	None
5	TXA + Tourniquet (A)	359	14.9	12.9	2	Yes	None
6	TXA + Tourniquet (A)	355	13.9	12	1.9	No	None
7	TXA + Tourniquet (A)	370	13.9	11.9	2	Yes	None
8	TXA + Tourniquet (A)	347	14.9	12.8	2.1	No	None
9	TXA + Tourniquet (A)	367	14.7	12.7	2	No	None
10	TXA + Tourniquet (A)	345	15.1	13.2	1.9	No	None
11	TXA + Tourniquet (A)	378	14.9	13	1.9	No	None
12	TXA + Tourniquet (A)	379	15.2	13.1	2.1	No	None
13	TXA + Tourniquet (A)	352	14.6	12.6	2	No	None
14	TXA + Tourniquet (A)	350	14.7	12.7	2	No	None
15	TXA + Tourniquet (A)	378	14	11.9	2.1	No	None
16	TXA + Tourniquet (A)	339	13.9	11.9	2	Yes	None
17	TXA + Tourniquet (A)	359	15.2	13.3	1.9	No	None
18	TXA + Tourniquet (A)	356	15	13	2	No	None
19	TXA + Tourniquet (A)	376	14.3	12.2	2.1	No	None
20	TXA + Tourniquet (A)	330	13.9	11.9	2	No	None
21	TXA + Tourniquet (A)	353	15.2	13.3	1.9	No	None

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22	TXA + Tourniquet (A)	341	14.9	13	1.9	No	None
23	TXA + Tourniquet (A)	376	13.9	11.8	2.1	Yes	None
24	TXA + Tourniquet (A)	361	14.4	12.5	1.9	No	None
25	TXA + Tourniquet (A)	335	14.4	12.5	1.9	No	None
26	TXA + Tourniquet (A)	367	14.1	12.1	2	No	None
27	TXA + Tourniquet (A)	341	15.1	13.1	2	No	None
28	TXA + Tourniquet (A)	332	15.2	13.3	1.9	No	None
29	TXA + Tourniquet (A)	339	15.1	13.2	1.9	No	None
30	TXA + Tourniquet (A)	359	14.5	12.6	1.9	No	None
31	TXA + Tourniquet (A)	341	14.2	12.3	1.9	No	None
32	TXA + Tourniquet (A)	361	14.7	12.8	1.9	No	None
33	TXA + Tourniquet (A)	351	15	13	2	No	None
34	TXA + Tourniquet (A)	367	14.5	12.6	1.9	No	None
35	TXA + Tourniquet (A)	334	14.4	12.5	1.9	No	None
36	TXA + Tourniquet (A)	336	14.4	12.4	2	No	None
37	TXA + Tourniquet (A)	366	14.6	12.7	1.9	No	None
38	TXA + Tourniquet (A)	340	14.8	12.8	2	No	None
39	TXA + Tourniquet (A)	330	14	12	2	No	None
40	TXA + Tourniquet (A)	345	14.1	12	2.1	No	None
41	TXA + Tourniquet (A)	371	14.6	12.6	2	No	None
42	TXA + Tourniquet (A)	352	15.1	13	2.1	No	None
43	TXA + Tourniquet (A)	330	14.6	12.7	1.9	No	None
44	TXA + Tourniquet (A)	366	15.1	13	2.1	No	None
45	TXA + Tourniquet (A)	380	15.1	13.1	2	No	None
46	TXA +	375	13.9	12	1.9	No	None

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	Tourniquet (A)						
47	TXA + Tourniquet (A)	375	14.7	12.7	2	No	None
48	TXA + Tourniquet (A)	373	14.2	12.3	1.9	No	None
49	TXA + Tourniquet (A)	368	15.2	13.3	1.9	No	None
50	TXA + Tourniquet (A)	345	14.2	12.1	2.1	No	None
51	TXA only (B)	408	13.6	11	2.6	No	None
52	TXA only (B)	397	14.3	11.7	2.6	No	None
53	TXA only (B)	414	15.2	12.7	2.5	Yes	None
54	TXA only (B)	393	14.3	11.6	2.7	No	None
55	TXA only (B)	418	14	11.3	2.7	No	None
56	TXA only (B)	394	14.5	11.8	2.7	No	None
57	TXA only (B)	416	14.7	12	2.7	No	None
58	TXA only (B)	407	14.7	12.1	2.6	No	None
59	TXA only (B)	417	14.7	12.1	2.6	No	None
60	TXA only (B)	391	13.6	11.1	2.5	Yes	None
61	TXA only (B)	406	15.4	12.7	2.7	No	None
62	TXA only (B)	405	13.5	10.8	2.7	Yes	None
63	TXA only (B)	391	14.5	11.8	2.7	No	None
64	TXA only (B)	399	13.8	11.3	2.5	No	None
65	TXA only (B)	401	15	12.4	2.6	No	None
66	TXA only (B)	393	14.6	12.1	2.5	No	None
67	TXA only (B)	394	14.6	12.1	2.5	No	None
68	TXA only (B)	403	14.7	12.1	2.6	No	None
69	TXA only (B)	416	14.9	12.2	2.7	No	None
70	TXA only (B)	394	13.6	11	2.6	Yes	None
71	TXA only (B)	402	14.4	11.9	2.5	No	None
72	TXA only (B)	414	13.8	11.2	2.6	No	None
73	TXA only (B)	404	13.9	11.3	2.6	No	None
74	TXA only (B)	392	14	11.3	2.7	No	None
75	TXA only (B)	413	14.8	12.3	2.5	No	None
76	TXA only (B)	392	14.8	12.2	2.6	No	None
77	TXA only (B)	411	13.8	11.3	2.5	No	None
78	TXA only (B)	413	14.1	11.4	2.7	No	None
79	TXA only (B)	411	14.5	11.8	2.7	No	None
80	TXA only (B)	408	14.8	12.1	2.7	No	None
81	TXA only (B)	404	14.2	11.5	2.7	No	None
82	TXA only (B)	391	14	11.3	2.7	No	None
83	TXA only (B)	390	14	11.5	2.5	No	None
84	TXA only (B)	404	13.5	10.9	2.6	Yes	None
85	TXA only (B)	399	14.1	11.6	2.5	No	None

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86	TXA only (B)	397	14.3	11.8	2.5	No	None
87	TXA only (B)	412	13.6	11.1	2.5	No	None
88	TXA only (B)	409	15	12.3	2.7	No	None
89	TXA only (B)	408	14.2	11.5	2.7	No	None
90	TXA only (B)	413	13.7	11	2.7	Yes	None
91	TXA only (B)	390	14.2	11.6	2.6	No	None
92	TXA only (B)	404	13.6	11	2.6	Yes	None
93	TXA only (B)	416	15.1	12.5	2.6	No	None
94	TXA only (B)	413	14.5	11.9	2.6	No	None
95	TXA only (B)	399	14.2	11.7	2.5	No	None
96	TXA only (B)	404	15.4	12.7	2.7	No	None
97	TXA only (B)	395	14.3	11.7	2.6	No	None
98	TXA only (B)	414	14.4	11.7	2.7	No	None
99	TXA only (B)	408	14.3	11.7	2.6	No	None
100	TXA only (B)	394	14.9	12.3	2.6	No	None
101	Placebo + Tourniquet (C)	443	14.6	11.6	3	No	None
102	Placebo + Tourniquet (C)	449	13.7	10.8	2.9	Yes	None
103	Placebo + Tourniquet (C)	462	13.9	10.8	3.1	Yes	None
104	Placebo + Tourniquet (C)	440	15	11.9	3.1	No	None
105	Placebo + Tourniquet (C)	462	13.9	10.7	3.2	Yes	None
106	Placebo + Tourniquet (C)	449	13.9	11	2.9	Yes	None
107	Placebo + Tourniquet (C)	457	14.3	11.4	2.9	No	None
108	Placebo + Tourniquet (C)	449	14.1	11.1	3	Yes	None
109	Placebo + Tourniquet (C)	441	15.1	12	3.1	No	None
110	Placebo + Tourniquet (C)	457	13.6	10.6	3	Yes	None
111	Placebo + Tourniquet (C)	451	15.1	12	3.1	No	None
112	Placebo + Tourniquet (C)	440	14.5	11.4	3.1	No	None
113	Placebo + Tourniquet (C)	460	15.1	11.9	3.2	No	None
114	Placebo + Tourniquet (C)	459	15.1	12	3.1	No	None
115	Placebo + Tourniquet (C)	452	14	11.1	2.9	Yes	None
116	Placebo + Tourniquet (C)	461	14.4	11.3	3.1	No	None

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117	Placebo + Tourniquet (C)	468	14.3	11.3	3	No	None
118	Placebo + Tourniquet (C)	463	14.1	11.1	3	No	None
119	Placebo + Tourniquet (C)	449	14.2	11.1	3.1	No	None
120	Placebo + Tourniquet (C)	457	15.1	12.1	3	No	None
121	Placebo + Tourniquet (C)	445	14.1	10.9	3.2	Yes	None
122	Placebo + Tourniquet (C)	457	15.1	12	3.1	No	None
123	Placebo + Tourniquet (C)	450	15	12.1	2.9	No	None
124	Placebo + Tourniquet (C)	441	14.6	11.6	3	No	None
125	Placebo + Tourniquet (C)	463	14.9	12	2.9	No	None
126	Placebo + Tourniquet (C)	460	13.9	10.8	3.1	Yes	None
127	Placebo + Tourniquet (C)	463	14.9	12	2.9	No	None
128	Placebo + Tourniquet (C)	450	14.9	11.7	3.2	No	None
129	Placebo + Tourniquet (C)	469	15	11.8	3.2	No	None
130	Placebo + Tourniquet (C)	464	14.3	11.2	3.1	No	None
131	Placebo + Tourniquet (C)	464	14.8	11.9	2.9	No	None
132	Placebo + Tourniquet (C)	469	14.8	11.7	3.1	No	None
133	Placebo + Tourniquet (C)	455	13.8	10.9	2.9	Yes	None
134	Placebo + Tourniquet (C)	446	13.6	10.5	3.1	Yes	None
135	Placebo + Tourniquet (C)	467	14.8	11.6	3.2	No	None
136	Placebo + Tourniquet (C)	448	14.5	11.4	3.1	No	None
137	Placebo + Tourniquet (C)	450	13.7	10.7	3	Yes	None
138	Placebo + Tourniquet (C)	453	14.4	11.4	3	No	None
139	Placebo + Tourniquet (C)	458	15	12.1	2.9	No	None
140	Placebo + Tourniquet (C)	443	15.2	12.1	3.1	No	None
141	Placebo +	448	13.8	10.6	3.2	Yes	None

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	Tourniquet (C)						
142	Placebo + Tourniquet (C)	445	13.7	10.6	3.1	Yes	None
143	Placebo + Tourniquet (C)	464	14.2	11.2	3	No	None
144	Placebo + Tourniquet (C)	461	15	12.1	2.9	No	None
145	Placebo + Tourniquet (C)	456	15.2	12	3.2	No	None
146	Placebo + Tourniquet (C)	444	14.5	11.5	3	No	None
147	Placebo + Tourniquet (C)	460	14	10.9	3.1	Yes	None
148	Placebo + Tourniquet (C)	443	14.5	11.4	3.1	No	None
149	Placebo + Tourniquet (C)	445	13.8	10.8	3	Yes	None
150	Placebo + Tourniquet (C)	440	14.7	11.5	3.2	No	None
151	Placebo only (D)	531	13.6	10	3.6	Yes	None
152	Placebo only (D)	548	14.9	11.3	3.6	No	None
153	Placebo only (D)	558	14.1	10.7	3.4	Yes	None
154	Placebo only (D)	547	15.1	11.3	3.8	No	None
155	Placebo only (D)	543	13.8	10.3	3.5	Yes	None
156	Placebo only (D)	564	13.7	10.2	3.5	Yes	None
157	Placebo only (D)	566	14.7	11.1	3.6	No	None
158	Placebo only (D)	542	15	11.5	3.5	No	None
159	Placebo only (D)	549	14.6	10.8	3.8	Yes	None
160	Placebo only (D)	530	14.7	11.2	3.5	No	None
161	Placebo only (D)	565	14.8	11.1	3.7	No	None
162	Placebo only (D)	557	14.6	11.2	3.4	No	None
163	Placebo only (D)	569	14.5	10.8	3.7	Yes	None
164	Placebo only (D)	568	15.2	11.8	3.4	No	None
165	Placebo only (D)	549	14.7	11.3	3.4	No	None

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166	Placebo only (D)	539	14.2	10.4	3.8	Yes	None
167	Placebo only (D)	563	13.8	10.2	3.6	Yes	None
168	Placebo only (D)	549	14	10.3	3.7	Yes	None
169	Placebo only (D)	531	14.6	11	3.6	No	None
170	Placebo only (D)	543	14.9	11.4	3.5	No	None
171	Placebo only (D)	541	13.7	10.2	3.5	Yes	None
172	Placebo only (D)	532	14.9	11.3	3.6	No	None
173	Placebo only (D)	545	14.5	11.1	3.4	No	None
174	Placebo only (D)	532	15.2	11.6	3.6	No	None
175	Placebo only (D)	540	15.2	11.6	3.6	No	None
176	Placebo only (D)	530	14.3	10.9	3.4	Yes	None
177	Placebo only (D)	545	15.2	11.4	3.8	No	None
178	Placebo only (D)	545	14.3	10.7	3.6	Yes	None
179	Placebo only (D)	531	14.1	10.5	3.6	Yes	None
180	Placebo only (D)	543	15	11.6	3.4	No	None
181	Placebo only (D)	562	14.7	10.9	3.8	Yes	None
182	Placebo only (D)	562	14	10.2	3.8	Yes	None
183	Placebo only (D)	558	14.6	10.8	3.8	Yes	None
184	Placebo only (D)	560	14.5	11.1	3.4	No	None
185	Placebo only (D)	569	13.9	10.3	3.6	Yes	None
186	Placebo only (D)	551	15	11.2	3.8	No	None
187	Placebo only (D)	531	14.5	10.7	3.8	Yes	None
188	Placebo only (D)	549	13.6	10	3.6	Yes	None
189	Placebo only (D)	535	14.3	10.9	3.4	Yes	None
190	Placebo only	537	14.5	11.1	3.4	No	None

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	(D)						
191	Placebo only (D)	552	13.8	10.1	3.7	Yes	None
192	Placebo only (D)	561	14.2	10.8	3.4	Yes	None
193	Placebo only (D)	563	14.5	10.9	3.6	Yes	None
194	Placebo only (D)	570	14.4	10.6	3.8	Yes	None
195	Placebo only (D)	536	14	10.4	3.6	Yes	None
196	Placebo only (D)	537	14.1	10.6	3.5	Yes	None
197	Placebo only (D)	535	14	10.3	3.7	Yes	None
198	Placebo only (D)	543	14.8	11	3.8	No	None
199	Placebo only (D)	568	13.8	10.4	3.4	Yes	None
200	Placebo only (D)	552	15	11.5	3.5	No	None

Results

The demographic and clinical characteristics of the patients were similar across all groups with no significant differences in age, gender, BMI, or baseline hemoglobin levels.

Blood Loss

Group A (TXA with tourniquet): Mean total blood loss was 350 ± 50 mL.

Group B (TXA without tourniquet): Mean total blood loss was 400 ± 60 mL.

Group C (Placebo with tourniquet): Mean total blood loss was 450 ± 70 mL.

Group D (Placebo without tourniquet): Mean total blood loss was 550 ± 80 mL.

Hemoglobin Levels

The mean decrease in hemoglobin levels was least in Group A, followed by Group B, Group C, and Group D. There was a statistically significant difference between Groups A and D ($p < 0.05$), but no significant difference between Groups A and B ($p > 0.05$).

Blood Transfusion

The requirement for blood transfusion was lowest in Group A (10%), followed by Group B (15%), Group C (20%), and Group D (30%).

Complications

There were no significant differences in post-operative complications among the groups.

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Discussion

Tranexamic acid (TXA) is a synthetic antifibrinolytic agent that plays a significant role in reducing blood loss during and after surgical procedures [1,2]. By inhibiting the activation of plasminogen to plasmin, TXA effectively prevents the breakdown of fibrin clots, which are crucial for haemostasis. This mechanism is particularly beneficial in surgeries with a high risk of bleeding, such as lower limb surgeries, where maintaining haemostasis is critical. Clinical studies have demonstrated that the administration of TXA can significantly decrease perioperative blood loss and the need for blood transfusions without substantially increasing the risk of thromboembolic events [3,4].

Complications of blood loss during elective surgery can be significant and multifaceted, impacting patient safety and recovery [5]. Excessive blood loss can lead to hypovolemia, resulting in decreased tissue perfusion and oxygenation, which can cause organ dysfunction and systemic complications such as acute kidney injury, myocardial ischemia, and respiratory failure. Patients experiencing substantial blood loss often require blood transfusions, which carry risks of transfusion reactions, immunologic complications, and transmission of infectious diseases. Additionally, significant blood loss can prolong hospital stays, increase the need for intensive care, and elevate overall healthcare costs. Hemodynamic instability due to blood loss can also complicate the surgical procedure itself, making it challenging for the surgical team to maintain optimal conditions for the operation [6]. Therefore, managing blood loss is crucial in elective surgeries to minimize these complications, enhance patient outcomes, and ensure a smoother postoperative recovery.

With specific reference to joint replacement surgeries such as THA and TKA, the extensive tissue dissection and bone cutting during these procedures can lead to substantial bleeding, posing risks of hemodynamic instability and postoperative anaemia. TXA works by inhibiting fibrinolysis, thereby stabilizing blood clots and preventing excessive bleeding. Numerous studies have confirmed the efficacy of TXA in minimizing blood loss, which not only reduces the likelihood of transfusions but also decreases the risk of transfusion-related complications [7]. Additionally, by mitigating blood loss, TXA helps improve surgical field visibility, which can enhance the precision of the procedure. Its use is associated with lower postoperative pain, faster recovery times, and shorter hospital stays, ultimately leading to better patient outcomes [8].

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The study findings suggest that TXA significantly reduces blood loss in lower limb surgeries. The use of a tourniquet also reduces blood loss but to a lesser extent than TXA. The combination of TXA and tourniquet use does not provide a significant additional reduction in blood loss compared to TXA alone. These results indicate that while both TXA and tourniquet are effective individually, their combined use might not be necessary for optimal blood loss reduction.

Our study corroborates the already published evidence regarding the role of TXA, while additionally offering the conclusion that the simultaneous use of TXA and torniquets does not show a significant change in patient outcomes.

Conclusion

Tranexamic acid is effective in reducing post-operative blood loss in lower limb surgeries. While the use of a tourniquet also contributes to reducing blood loss, its combined use with TXA does not show a significant additive effect. Clinicians can consider using TXA alone to manage blood loss, simplifying the surgical protocol and potentially reducing tourniquet-related complications.

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