Tranexamic Acid Efficacy, Fibrin Structure & Fibrinolysis

Summary of a mechanistic in vitro study | Biomolecules 2026;16:696

Why this matters

Tranexamic acid (TXA) is a cornerstone antifibrinolytic used across trauma, cardiac surgery, and obstetrics. Large randomised trials have established its life-saving benefit when given early in active bleeding. Yet prophylactic TXA has repeatedly failed to show meaningful benefit — a discrepancy that has remained incompletely understood. This study provides a mechanistic explanation: TXA efficacy depends not on dose alone, but on timing and the plasminogen/TXA balance within the clot microenvironment.

Study at a glance

Study design	In vitro mechanistic study	purified fibrin clot systems
Key platforms	ClotPro® viscoelastic testing, confocal microscopy, turbidimetry, scanning electron microscopy (SEM)
TXA range	0–128 µM (clinically relevant plasma range; ~0–20 mg/L after IV administration)
Plasminogen	0.25, 0.75, and 2.5 µM — sub-physiological to physiological
Two models	Therapeutic: TXA + tPA present simultaneously during clot formation (mimics active bleeding). Prophylactic: TXA incorporated into clot before extrinsic tPA challenge.
Source	Balog Virag et al. Biomolecules 2026;16:696. Semmelweis University, Budapest.

What the ClotPro® assays contributed

- Viscoelastic assay (tPA-incorporated model) — TXA (64–128 µM) consistently prolonged lysis time (LT) and increased maximal clot firmness (MCF) across all plasminogen concentrations, providing clear dose-dependent antifibrinolytic signal.
- Discriminatory performance — ClotPro produced the most interpretable results of all platforms tested. Confocal microscopy showed paradoxical findings; turbidimetry showed complex absorbance changes. ClotPro gave the cleanest, most clinically translatable signal.
- Clinical assay relevance — The simultaneous TXA + tPA model directly mirrors the therapeutic clinical scenario. This supports the biological rationale for ClotPro's tPA-sensitive channels (ECA, TPA tests) in monitoring antifibrinolytic response in real time.

Key findings

Finding	Detail
TXA is pro-fibrinolytic when given prophylactically	At physiological plasminogen (2.5 μM), TXA pre-incorporated into fibrin accelerated clot lysis — the paradoxical opposite of its intended effect. This was plasminogen-concentration dependent.
TXA is consistently antifibrinolytic in the therapeutic model	When TXA and tPA were present simultaneously during clot formation, TXA prolonged LT and increased MCF regardless of plasminogen concentration — consistent with benefit in active bleeding.
TXA remodels fibrin architecture at sub-therapeutic concentrations	SEM showed TXA doubled fibrin fibre diameter in the top quartile at just 16 μM — well below the 60–95 μM antifibrinolytic threshold. Thicker fibres create larger pores, increasing plasmin susceptibility.
The plasminogen/TXA ratio governs net effect	It is not TXA dose alone, but the balance between available plasminogen and TXA within the clot microenvironment that determines whether TXA protects or paradoxically accelerates lysis.
Resuscitation dilution may improve TXA efficacy	Volume resuscitation in major trauma lowers circulating plasminogen — conditions where the authors observed improved antifibrinolytic TXA effect, supporting early administration.

Practical implications for clinicians

- Timing matters more than dose — TXA is most effective when given concurrently with active bleeding. Prophylactic administration may not deliver expected antifibrinolytic protection, and may paradoxically accelerate fibrinolysis in some conditions.
- Do not assume TXA is always antifibrinolytic — Net effect depends on the clot microenvironment. Real-time viscoelastic monitoring can confirm whether antifibrinolytic activity is present in the individual patient.
- Relevant to trauma, cardiac surgery, and obstetric haemorrhage — These clinical scenarios align directly with settings where ClotPro®-guided TXA monitoring adds the greatest value.
- Supports early TXA administration — Provides additional mechanistic support for guidelines (CRASH-2, WOMAN trial) favouring early therapeutic use over prophylactic dosing.

Important considerations

- In vitro purified system — lacks platelets, FXIII crosslinking, TAFI activity, red blood cells, and flow. Findings are mechanistic and should not be directly translated to clinical protocols.
- Findings are hypothesis-generating; validation in whole blood and patient-derived samples is required.
- Clinical TXA decisions should follow local protocols, governance, and patient-specific assessment.

Suggested customer conversation points

- How does your service currently monitor the fibrinolytic response to TXA in patients with major haemorrhage?
- Are there patient groups — resuscitated trauma, cardiac surgery, obstetric haemorrhage — where real-time confirmation that TXA is working as expected would change clinical decisions?
- Would a ClotPro®-guided TXA monitoring protocol fit your current viscoelastic testing workflow?

Visual summary

At-a-glance mechanistic insights from Balog Virag et al., Biomolecules 2026;16:696.

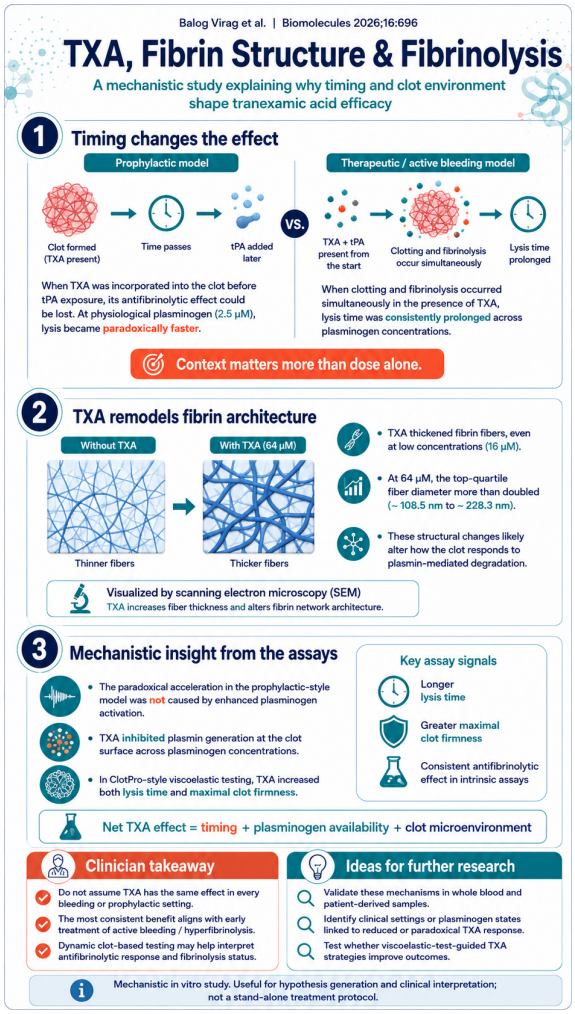

Figure: Educational visual summary. Balog Virag et al., Biomolecules 2026;16:696.

Source and disclaimer

Balog Virag K et al. Biomolecules 2026;16:696. DOI: https://doi.org/10.3390/biom16050696

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