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Role of Tranexamic Acid in Hemostasis in Liposuction

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Abstract:

Background: Liposuction is one of the most commonly performed aesthetic surgical procedures and is frequently associated with intraoperative blood loss, postoperative ecchymosis, and prolonged recovery time. Effective hemostasis is therefore essential to improve surgical outcomes and patient safety. Tranexamic acid (TXA), a synthetic antifibrinolytic agent, has been widely used to reduce bleeding in various surgical specialties; however, its role, efficacy, and safety in liposuction procedures remain an area of ongoing clinical interest and investigation.

Keywords: Tranexamic acid; Liposuction; Hemostasis; Blood loss; Antifibrinolytic agents; Aesthetic surgery.

Introduction:

Because excessive blood loss can result in hematoma development, slower recovery, and higher surgical risks, hemostasis is essential to the safety and effectiveness of liposuction (1). Since its inception, liposuction has developed with improved methods to reduce intraoperative and postoperative bleeding, such as energy-assisted liposuction, tranexamic acid (TXA), tumescent anesthesia, and careful surgical planning (2).

The mechanics of hemostasis in liposuction, techniques to reduce blood loss, and the avoidance and treatment of postoperative problems such hematomas and seromas are all covered in this chapter.

Mechanism of hemostasis in liposuction:

Hemostasis in liposuction relies on several physiological and surgical factors, including:

1. **Vasoconstriction:** Induced by epinephrine in tumescent solution, reducing capillary perfusion and intraoperative bleeding **(3).**

2. **Platelet Activation & Clot Formation:** Following fat aspiration, platelets aggregate at the site of vascular injury, initiating the coagulation cascade **(1).**

3. **Mechanical Compression:** Postoperative compression garments reduce dead space and enhance clot stabilization **(2).**

4. **Tumescent Anesthesia (The Gold Standard):** The best way to minimize blood loss during liposuction is to use the tumescent technique. Prior to fat aspiration, a solution including lidocaine, epinephrine, and crystalloid fluid is injected into the subcutaneous tissue.

5. **Tranexamic Acid (TXA) in Liposuction:** By preventing plasminogen activation, the antifibrinolytic drug TXA stabilizes clot formation and lessens bleeding during and after surgery. **(2).**

Prevention and Management of Hematomas & Seromas:

Hematomas and seromas are still frequent postoperative problems in liposuction despite improvements in hemostasis.

- **Hematoma:**

Risk Factors: Large-volume liposuction, inadequate hemostasis, coagulation disorders.

Preventive Strategies:

a. Careful hemostasis during surgery (cautery for active bleeders).

b. Postoperative compression clothing, which minimizes dead space and keeps blood from collecting.

c. Steer clear of NSAIDs for 48–72 hours after surgery because they affect platelet function.. **(2)**

- **Seroma:**

Excess fluid buildup in dead space after liposuction causes seromas.

Preventive Measures:

a. Wear compression clothing for two to four weeks to lessen the accumulation of tissue fluid.

b. Controlled suction levels and little undermining (limited tissue stress).

b. Placing drains in high-risk situations (large-volume liposuction). **(3)**

Management:

a. Aspiration and compression of small seromas.

b. Recurrent or large seromas → Sclerotherapy or drain placement **(1)**

Limitations and Considerations:

Despite advancements in hemostasis, several challenges remain:

1. Lidocaine Toxicity Risk: Cardiac and central nervous system toxicity may result from excessive tumescent infiltration (2).

2. TXA Contraindications: Patients with thromboembolic illnesses should utilize TXA with caution.

3. Variable Skin Retraction: After liposuction, older individuals or those with low elasticity may still have skin laxity (1).

4. Adverse effects and toxicity of adrenaline.

5. Coagulopathies.

6. To maximize safety, future studies should concentrate on customized hemostatic procedures.

Tranexemic Acid

A synthetic antifibrinolytic drug called tranexamic acid (TXA) is essential for lowering surgical blood loss and the need for transfusions. TXA stabilizes blood clots and stops excessive bleeding by blocking plasminogen activation (4). Because of its effectiveness and good safety profile, TXA has been widely used in orthopedic, cardiovascular, plastic, and trauma procedures since its inception (5).

The mechanism of action, pharmacodynamics, pharmacokinetics, clinical uses in surgery, safety issues, and limits of TXA are all covered in this chapter.

Pharmacokinetics:

The antifibrinolytic TXA competitively inhibits the activation of plasminogen to plasmin (6).

Similar to the 10-fold less potent antifibrinolytic aminocaproic acid (7), it acts as a noncompetitive plasmin inhibitor at higher concentrations.

Tranexamic acid binds more firmly than aminocaproic acid to the strong and weak receptor sites of the plasminogen molecule in a ratio that reflects the different potencies of the compounds. Tranexamic acid reduces plasmin generation and activity, which may prevent angioedema attacks in patients with hereditary angioedema by decreasing plasmin-induced activation of the first complement protein (C1) (8).

GABA (A) receptor off-target antagonism may be associated with convulsions and hyperexcitability following tranexamic acid therapy (9).

The danger appears to be elevated when given improperly or following cardiovascular surgery (7).

EEG monitoring may be helpful for patients who have a history of seizures.

Routes of administration:

The effectiveness and safety of TXA are significantly influenced by the method of administration. The main routes—intravenous (IV), oral, intramuscular (IM), topical, and intra-articular—are compared in this chapter along with their pharmacokinetics, uses, and hazards.

- **Intravenous (IV) administration:**

IV TXA offers quick therapeutic plasma concentrations and instant absorption. It is frequently utilized in procedures that call for instant hemostasis (10). Nevertheless, venous access is necessary for IV administration, and there is a chance of thromboembolism (5).

- **Oral administration:**

Peak plasma levels of oral TXA occur two to three hours after administration, with a bioavailability of about thirty to fifty percent (11). Although it has few uses in acute surgical settings, it is frequently used for chronic bleeding problems.

- **Intramuscular (IM) administration:**

Within fifteen minutes, IM TXA reaches therapeutic levels, which it sustains for three hours (11). Although this method can result in hematomas or local pain, it is helpful in pre-hospital trauma care.

- **Topical administration:**

Direct application of topical TXA to the surgical site results in high local concentrations and little systemic absorption (12). It is frequently utilized in plastic and orthopedic procedures.

- **Intra-articular administration:**

When arthroscopic procedures are performed, intra-articular TXA is injected into joint spaces to successfully reduce postoperative hemorrhage (13). To avoid infections, though, it necessitates the use of stringent aseptic procedures.

- **Absorption:**

When administered orally, the bioavailability is around 30–50% of the ingested dose and is unaffected by food. This occurs quickly after IV treatment (peak action within 30 minutes).

- **Volume of distribution:**

Tranexamic acid has a steady-state volume of distribution of 0.39 L/kg and an initial volume of distribution of 0.18 L/kg. 5. Tranexamic acid is dispersed into the aqueous humour of the eye and cerebral fluid at concentrations that are about a tenth of normal plasma values. Additionally, tranexamic acid can pass across the placenta because it is found in cord blood at amounts comparable to those found in maternal plasma. **(6).**

- **Proteins Binding:**

About 3% of tranexamic acid is protein-bound in plasma at therapeutic concentrations. This protein binding is most likely explained by tranexamic acid's binding to serum plasminogen, as it does not bind to serum albumin. **(6).**

- **Metabolism:**

Tranexamic acid metabolism is poorly known, however it doesn't appear to represent a significant drug removal strategy. According to the prescribing information, approximately 1% and 0.5% of an oral dose are excreted as a dicarboxylic acid and an acetylated metabolite, respectively. **(6).**

- **Half-life:**

After two to three hours of intravenous treatment, additional dose or infusion is necessary for a long-lasting impact. **(14).**

- **Clearance:**

The plasma clearance of txa is 110-116 ml/min (**6).**

- **Excretion:**

- Renal impairment necessitates dose adjustment because 95% of the administered dose is excreted in urine as the parent medication remains unaltered (4). 90% of TXA administered intravenously is eliminated within 24 hours, whereas only 39% of oral TXA is eliminated in the same time frame (7). This indicates that the rate of clearance varies depending on the mode of administration.

- **Drug -drug interaction:**

- Albutrepenonacog alfa, aprotinin, calcium, peroctogog alfa, and aminocaproic acid are among the other thrombogenic medications that it boosts the thrombogenic action of.

- Combining TXA with Alteplase and Anistreplase reduces its therapeutic effectiveness (7).

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- **Food interaction:**

The drug's desposition is not substantially impacted by whether it is administered with or without food. **(7).**

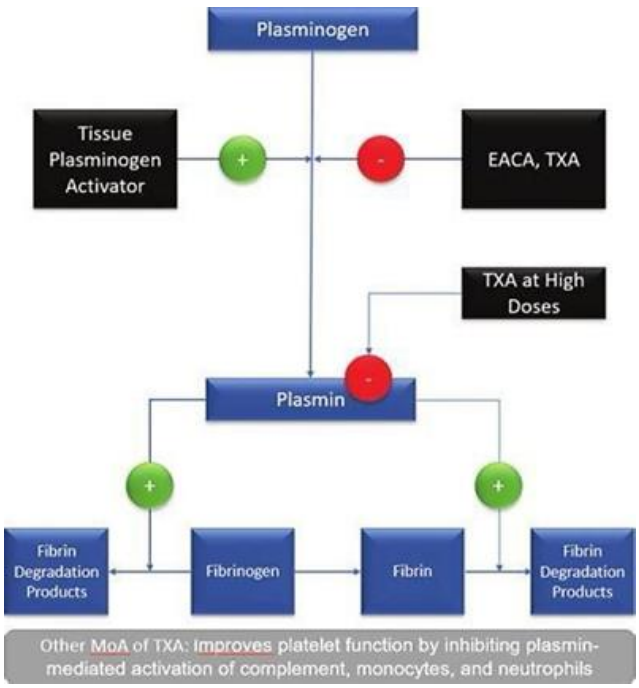

Figure (1): Tranexamic acid exerts its antifibrinolytic effect by binding to plasminogen and preventing its conversion to plasmin, thereby stabilizing fibrin clots and reducing bleeding risk **(11).**

Clinical Applications of TXA in Surgery:

TXA is used in a number of surgical procedures to minimize intraoperative blood loss, reduce the need for transfusions, and improve patient outcomes since it is an excellent hemostatic drug that can increase clot stability without causing severe thrombosis.

- **TXA in orthopedic surgery:**

TXA dramatically lowers blood loss and the requirement for transfusions in total knee and hip replacements.

Intraoperative and postoperative hemorrhage are decreased by IV TXA (10–20 mg/kg prior to surgery) (15).

Intraoperative application of topical TXA (1–3 g in 50–100 mL saline) effectively stabilizes clots at the surgical site (16).

Clinical Evidence:

TXA in orthopedic surgery reduced transfusion rates by 30–50%, according to a meta-analysis of 45 randomized controlled trials (RCTs). **(5).**

- **TXA in cardiovascular surgery:**

To lower the risk of bleeding, TXA is frequently utilized in valve replacement and coronary artery bypass grafting (CABG).

Intraoperative blood loss is decreased by IV TXA infusion (loading dose: 10–15 mg/kg, followed by 1 mg/kg/hr infusion) (17).

decreased the requirement for postoperative transfusion by 50% by reducing postoperative chest tube drainage (16).

Important Point to Remember: Because of cerebral stimulation, high-dose TXA may raise the incidence of postoperative seizures (17).

- **TXA in Trauma and Emergency Surgery:**

The **CRASH-2 trial (10**) demonstrated the life-saving benefits of TXA in trauma patients with active bleeding.

Findings:

Using TXA (1 g IV over 10 minutes and subsequently 1 g over 8 hours) decreased trauma-related death by 15%.

2. When given within three hours of damage, the greatest effect was shown (18).

In trauma resuscitation methods, TXA is currently considered standard, particularly in cases of major hemorrhage.

- **TXA in Plastic and Aesthetic Surgery:**

TXA is becoming more and more used in plastic surgery, especially in rhinoplasty, abdominoplasty, and liposuction.

TXA in Liposuction:

Blood loss and postoperative bruising are decreased when TXA (1 mg/mL) is added to tumescent solution. **(2)**

- **TXA in Rhinoplasty:**

Topical TXA decreases epistaxis, hematoma formation and intraoperative blood loss. **(19)**

- **TXA in Gynecologic Surgery:**

TXA is frequently used to stop excessive bleeding during hysterectomies and cesarean sections.

World Health Organization (WHO) Guidelines (2021):

1. For postpartum hemorrhage (PPH), IV TXA (1 g slow IV push) is advised.

2. When administered within three hours of delivery, TXA lowers maternal mortality in cases of severe PPH by 30% (20).

Safety and Limitations of TXA in Surgery:

While TXA is generally safe, certain risks must be considered:

- **Thromboembolism Risk:**

Although TXA does not substantially raise the incidence of venous thromboembolism (VTE), high-risk patients should exercise caution. **(4)**.

- **Seizures:**

Particularly in cardiac surgery, high dosages (>100 mg/kg) raise the risk of postoperative seizures. **(17).**

- **Renal Clearance Issues:**

Patients with chronic kidney disease (CKD) require dose modifications since TXA is eliminated through the kidneys. **(16).**

Tranexamic Acid (TXA) in Liposuction:

Millions of liposuction treatments are performed each year, making it one of the most popular cosmetic procedures in the world (21). Excessive intraoperative bleeding and postoperative ecchymosis continue to be concerns despite being very safe, frequently resulting in prolonged recovery times and possible consequences (22). Because it can stabilize blood clots and decrease fibrinolysis, tranexamic acid (TXA), a synthetic antifibrinolytic drug, has shown promise as a liposuction adjuvant (16).

Although TXA's involvement in liposuction is still being investigated, it has been well researched in a number of surgical specialties, including orthopedic, cardiac, and trauma surgery (5). This chapter examines the mechanisms, administration routes, clinical effectiveness, and safety concerns of TXA in liposuction.

- **Mechanism of Action of TXA in Liposuction:**

By reversibly attaching to plasminogen, TXA inhibits its transformation into plasmin, the enzyme that breaks down fibrin (16). This inhibition lessens intraoperative bleeding and postoperative bruising by stabilizing blood clots (4). TXA helps reduce microvascular hemorrhage during liposuction, which involves manipulating and removing huge amounts of subcutaneous fat. This improves hemostasis and lowers postoperative ecchymosis **(2).**

- **Routes of TXA Administration in Liposuction:**

- For liposuction, TXA has been administered via a number of ways, each with unique benefits and things to keep in mind.

- **Intravenous (IV) Administration:**

- The most researched method of delivering TXA during surgery is IV administration.

- Preoperative dosages of 10 to 20 mg/kg have been used in trials to decrease perioperative blood loss because of its quick absorption and systemic distribution (16). Systemic injection is beneficial, but it raises concerns about possible thromboembolic consequences, especially in patients who are at high risk (5).

- **Local Infiltration via Tumescent Solution:**

In liposuction, adding TXA to the tumescent solution is becoming more and more common. By delivering TXA straight to the surgical site, this technique concentrates its antifibrinolytic actions where tissue damage takes place (2).

Studies using concentrations of 1 mg/mL in tumescent fluid have shown limited systemic absorption and decreased blood loss and surgical bruising (19).

- **Topical Application:**

A diluted solution of 1 g of TXA in 100 mL of normal saline can be used to irrigate the surgical site after liposuction. This method has been successful in reducing bleeding during orthopedic surgery, and it might have comparable advantages during liposuction. **(4).**

- **Clinical efficacy of TXA in liposuction:**

1. The efficiency of TXA in lowering intraoperative blood loss and postoperative bruising in liposuction has been assessed in a number of trials.

2. **Reduction in Blood Loss:** Administration of TXA considerably reduces intraoperative bleeding, especially when combined with the tumescent solution. **(2).**

3. **Decrease in Ecchymosis:** Patients treated with TXA experience less postoperative bruising, attributed to the stabilization of microvascular clots **(19).**

4. **Minimal Side Effects:** Studies report no significant increase in complications, indicating a favorable safety profile **(16).**

- **Clinical Comparison: IV vs. Local TXA in Liposuction:**

Whether IV versus local administration improves patient outcomes, safety, and blood loss reduction is a major point of contention in the use of TXA for liposuction.

Efficacy in Reducing Blood Loss:

It has been demonstrated that both local and IV TXA considerably lower intraoperative blood loss during liposuction. Comparative studies, however, show:

Although it has little direct effect on local capillary bleeding, IV TXA (10–20 mg/kg) efficiently lowers blood loss (17).

Local TXA (1 mg/mL in tumescent solution) decreases postoperative bruises and offers more focused bleeding control at the surgical site (2).

1. Safety & Side Effects

IV TXA is associated with an increased risk of systemic thromboembolism, especially in patients with predisposed factors (5).

For high-risk patients, local TXA is preferred because of its decreased systemic absorption, which lowers the risk of thromboembolism (19).

Seizure Risk: While local TXA does not pose this risk, high-dose IV TXA (>50 mg/kg) has been associated with an elevated incidence of seizures (17).

2. Practical considerations:

Table (1): Practical considerations regarding use of TXA in liposuction **(23)**

	IV TXA	**Local TXA**
Administration Time	Rapid (preoperative injection)	Integrated into tumescent solution
Systemic Risk	Higher (thromboembolism, seizures)	Lower

Localized Bleeding Control	Indirect	Direct, effective for reducing bruising
Ease of Use Requires	Requires IV access	Simple, incorporated into standard technique

3. Combined administration:

The advantages of administering TXA both locally and intravenously have been investigated in certain trials. According to a randomized controlled research, employing both techniques produced better hemostasis than either technique alone, which significantly decreased intraoperative blood loss and ecchymosis (5). Even though this strategy seems promising, more investigation is required to identify the best dosing plans and safety profiles.

Patient Selection Criteria for TXA Use in Liposuction:

The use of TXA during liposuction should be carefully evaluated in light of each patient's unique circumstances.

- **Bleeding Risk:** Patients with a history of excessive bleeding, anemia, or those undergoing large-volume liposuction may benefit the most from TXA **(2).**
- **Thromboembolic Risk:** Individuals with a personal or family history of thromboembolism require careful evaluation before TXA administration, particularly via the IV route **(16).**
- **Renal Function:** As TXA is primarily excreted through the kidneys, patients with renal impairment may require dose adjustments or alternative approaches **(4).**
- **Medication Use:** To prevent possible drug interactions, especially with anticoagulants and hormonal therapy, it is crucial to review concurrent drugs. **(17).**

Contraindications and Precautions:

Although TXA is typically safe, there are some contraindications and safety measures that need to be followed:

- History of pulmonary embolism (PE) or deep vein thrombosis (DVT): TXA may raise the risk of thromboembolism in those who are vulnerable (5).
- Severe Renal Impairment: TXA buildup brought on by decreased renal clearance may have negative consequences (16).
- History of Seizures: Excessive IV TXA dosages have been associated with a higher risk of seizures, especially in patients undergoing heart surgery (17).

Potential Drug Interactions:

- TXA's safety and effectiveness may be impacted by interactions with other drugs.
- Estrogen-Containing Contraceptives: TXA may raise the risk of thromboembolism when combined with estrogen-based contraceptives (4). Patients undergoing surgery should be evaluated for other birth control options.
- Anticoagulants: TXA needs to be closely watched since it may reverse the benefits of anticoagulant therapy (16).
- Fibrinolytic Agents: TXA may make medications that encourage fibrinolysis, like tissue plasminogen activator (TPA), ineffective (5).

Long-Term Safety and Future Research Directions:

Long-term safety information is still scarce, despite the well-established short-term advantages of TXA in liposuction. Future research topics include:

- Optimal Dosing Strategies: Identifying the safest and most efficient dosages for both local and IV delivery in patients undergoing liposuction (2).
- Thormboembolic Risks: To determine whether TXA raises the risk of PE or DVT in liposuction patients, more research is required (16).
- Comparative Effectiveness: Extensive clinical trials evaluating the administration of IV, local, and combination TXA would yield important information about optimal practices (5).

Future Research Directions:

Although TXA has a well-established role in liposuction, there are a few areas that need more research:

1. Guidelines for Optimal Dosage and Administration:

TXA doses ranging from 1 mg/mL (local) to 10–20 mg/kg (IV) have been investigated in recent investigations; however, additional randomized controlled trials are required to ascertain the optimal balance between safety and efficacy (19).

It's also necessary to determine whether different body parts and liposuction methods call for different dosages (2).

2-Long-Term Safety in Aesthetic Surgery:

There is no information on the long-term results of cosmetic treatments like liposuction, and the majority of TXA research has concentrated on orthopedic, cardiac, and trauma surgery (5). Future research should look into any potential dangers associated with recurrent exposure to TXA during elective cosmetic surgery, such as chronic thromboembolic events, delayed wound healing, or unanticipated side effects (17).

3. The Function of TXA in Combination Treatments:

New adjunctive procedures including power-assisted liposuction (PAL), laser-assisted liposuction (LAL), and radiofrequency-assisted liposuction (RFAL) are growing in popularity as technology develops (2). To ascertain whether TXA's effectiveness varies when paired with these modalities and whether there are any interactions between TXA and newly developed energy-based liposuction procedures, more investigation is required (19).

4. TXA Protocols Specific to Patients:

Future research ought to examine the customized application of TXA, taking into account variables like procedure complexity, patient age, BMI, and medical history (16). To maximize safety and efficacy in various patient populations, AI-driven predictive models may aid in the development of customized TXA dosing algorithms (5).

Final thoughts:

TXA has transformed the way blood loss is managed during liposuction, leading to safer, more effective treatments and better patient outcomes (2). Local TXA infiltration seems to provide the optimum mix of safety and efficacy for the majority of patients, but both IV and local delivery techniques are beneficial (19).

In the realm of aesthetic surgery, more research is required to improve TXA dose, safety profiles, and long-term effects, despite its increasing use (5). TXA's function in liposuction and other cosmetic treatments will probably continue to develop as tailored medicine and surgical technology grow, improving outcomes for both patients and surgeons (17).

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