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Impact of Tranexamic Acid application in plastic surgery a literature review

Impacto de la aplicación del Ácido Tranexámico en la cirugía plástica desde una revisión bibliográfica

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Resumen

El presente estudio de investigación tiene como objetivo analizar la evidencia científica sobre el uso del ácido tranexámico en cirugía plástica, estética y reconstructiva, mediante la revisión de estudios, con el fin de evaluar su aplicación en el campo quirúrgico.

El planteamiento de investigación surge a partir de la reflexión del por qué no está estandarizada la dosis de aplicación del ácido tranexámico en cirugía plástica, así como la vía de administración, contraindicaciones y dosis de aplicación. Aquí nace la necesidad de llevar a cabo esta búsqueda bibliográfica. La cirugía plástica se ha consolidado hoy en día en una disciplina innovadora que no se limita únicamente a mejorar la apariencia física, sino que también a corregir malformaciones y secuelas derivadas de traumatismos. A lo largo de los años, los avances tecnológicos han transformado significativamente esta especialidad, optimizando no sólo los procedimientos quirúrgicos, sino también estéticos y reconstructivos.

La metodología empleada fue una revisión bibliográfica en bases de datos como PubMed, ScienceDirect, Dialnet, SciELO, Google Académico, Concytec, Cochrane, Conamed y MedlinePlus seleccionando estudios recientes sobre el uso del ácido tranexámico en procedimientos de cirugía plástica. La revisión bibliográfica reporta como hallazgos que el ácido

tranexámico puede ser administrado por vía oral, tópica o intravenosa, además de disminuir significativamente el sangrado perioperatorio y postoperatorio, reduciendo la formación de hematomas y acelerando la recuperación sin aumentar el riesgo de trombosis; sin embargo, es importante señalar que existen ciertas contraindicaciones para su aplicación tales como la intravenosa puede causar hemorragia subaracnoidea, coagulación intravascular activa, la hipersensibilidad al TXA y la vía oral donde su uso concomitante de anticonceptivos hormonales combinados, puede causar enfermedad tromboembólica activa o antecedentes de riesgo intrínseco de trombosis o hipersensibilidad al TXA.

Partiendo del análisis de la revisión bibliográfica en los resultados más destacados se encontró que existe innovación en la aplicación y uso del ácido tranexámico en las cirugía plástica, estética y reconstructiva, además de otras cirugías, debido a que el ATX impacta en la reducción del sangrado intraoperatorio y existe una mejora de los tiempos de recuperación en el paciente. Su aplicación en la fase preoperatoria, y ha demostrado ser un recurso clave para minimizar complicaciones y optimizar los resultados quirúrgicos. Esta investigación concluye en que la aplicación e implementación del ácido tranexámico en el campo de la cirugía plástica, estética y reconstructiva, impacta en gran medida, brinda seguridad y efectividad en los procedimientos quirúrgicos. Su alcance abarca tanto la cirugía estética como la reconstructiva, consolidándose como una herramienta fundamental para mejorar la calidad de la atención y satisfacción física del paciente.

El ATX es sin duda, una herramienta versátil que se utiliza no sólo en cirugía plástica, sino también en diversas especialidades quirúrgicas. Aunque su aplicación ayuda a reducir sangrados, hemorragias y la formación de hematomas en general, en cirugía plástica se centra más en mejorar la recuperación estética y en reducir complicaciones postoperatorias. En cambio, en otras especialidades, su función principal es minimizar la pérdida sanguínea y disminuir la necesidad de transfusiones.

Palabras clave: Ácido tranexámico, Beneficios, Cirugía plástica, Dosis de aplicación, Vía de administración.

Abstract

The present study aims to analyze the scientific evidence on the use of tranexamic acid in plastic, aesthetic, and reconstructive surgery by reviewing existing literature to evaluate its application in the surgical field.

The research stems from the lack of standardization in the dosage, route of administration, and contraindications of tranexamic acid in plastic surgery. This gap in clinical guidelines highlights the need for a comprehensive bibliographic review. Plastic surgery has evolved into an innovative field that extends beyond aesthetic enhancements to include the correction of congenital malformations and trauma-related sequelae. Over the years, technological advances have significantly transformed this specialty, optimizing not only surgical procedures, but also aesthetic and reconstructive ones.

This study employs a bibliographic review methodology, analyzing data from sources such as PubMed, ScienceDirect, Dialnet, SciELO, Google Scholar, Concytec, Cochrane, Conamed and

MedlinePlus selecting recent studies on the use of tranexamic acid in plastic surgery procedures. The bibliographic review reports as findings that the Tranexamic acid can be administered orally, topically or intravenously, in addition to significantly reducing perioperative and postoperative bleeding, reducing hematoma formation and accelerating recovery without increasing the risk of thrombosis; however, it is important to note that there are certain contraindications for its application such as intravenous can cause subarachnoid hemorrhage, active intravascular coagulation, hypersensitivity to TXA and oral route where concomitant use of combined hormonal contraceptives can cause active thromboembolic disease or history of intrinsic risk of thrombosis or hypersensitivity to TXA.

Based on the analysis of the bibliographic review, the most notable results revealed innovation in the application and use of tranexamic acid in plastic, aesthetic, and reconstructive surgery, as well as other surgeries. TXA impacts the reduction of intraoperative bleeding and improves patient recovery times. Its application in the preoperative phase has proven to be a key resource for minimizing complications and optimizing surgical outcomes. This research concludes that the application and implementation of tranexamic acid in the field of plastic, aesthetic, and reconstructive surgery has a significant impact, providing safety and effectiveness in surgical procedures. Its application extends to both aesthetic and reconstructive surgeries, establishing it as a fundamental tool for improving patient care and satisfaction.

The TXA is undoubtedly a versatile tool that is used not only in plastic surgery, but also in various surgical specialties. Although its application helps to reduce bleeding, bleeding and the formation of bruises in general, in plastic surgery it focuses more on improving aesthetic recovery and reducing postoperative complications. In other specialties, on the other hand, its main function is to minimize blood loss and reduce the need for transfusions.

Keywords: Tranexamic acid, Benefits, Plastic surgery, Application dose, Route of administration.

I. Introduction

This research emphasizes that there is a search to ensure safe surgery and reduce bleeding and hematomas in a surgical intervention, pointing out that there are three key moments that a patient faces, the preoperative, surgical and post-surgical act, an alternative is tranexamic acid that will favor the safety of the patient before, during and after the intervention. Blood losses are merely inevitable, what makes each patient different is his clinical condition. In this sense, the need arises to review the existing scientific literature to better understand the efficacy, safety and possible limitations of tranexamic acid in the context of plastic surgery in the context of plastic, aesthetic and reconstructive surgery.

The aim of this research is to analyze the scientific evidence on the use of tranexamic acid in plastic, aesthetic and reconstructive surgery, by reviewing studies, in order to evaluate its application in the surgical field.

This literature review focuses on examining the available scientific evidence on the effectiveness of tranexamic acid in the reduction of intraoperative blood loss, as well as in the prevention of postoperative complications such as hematomas, edema and ecchymosis. The effects on the recovery time of the patient are also considered, analyzed

the possible risks associated with its administration, including the following possible risks associated with its administration, including the dose and the different routes of application of tranexamic acid. Through this critical exploration, the aim is to identify clinical guidelines that contribute to optimizing the safety and efficacy of surgical procedures in which this drug is used.

In a research conducted in 2019, it was stated that since the 1950s', ATX has shown proven efficiency in the prevention of postoperative bleeding due to its antifibrinolytic effect, as well as its anti-inflammatory activity in surgical procedures in a wide range of medical specialties (Guillermo Blugerman, Diego Schavelzon, Isaac Zilinsky, Giuseppe del Torto, Miguel Mussi Becker, Victoria Schavelzon, Guido Blugerman, 2019).

For their part Burgos, D. Á., & Paoletti, O. (2019) state that ATX is a hydrophilic antifibrinolytic drug that can be administered orally, intravenously or used topically to decrease intraoperative bleeding in surgical interventions, its use is related to seizures, hypersensitivity, visual or ocular adverse effects, dizziness, headache, sinus and nasal symptoms, back pain, abdominal pain, musculoskeletal pain, joint pain, muscle cramps, migraine, anemia and fatigue.

Gnädinger Roca, S. (2024) talks about excessive blood loss in surgery, re-exploration, hematoma and postoperative anemia can be provoked, leading to blood transfusion. Studies have shown that acute anemia is a very frequent complication in plastic surgery as in other specialties, associated with high morbidity and mortality rates; tranexamic acid does not permit activation of plasminogen, preventing temporary lysis of clots. This same author conducted a study where a total of 409 patients were included and divided into two groups: 207 patients in whom the created blood loss management protocol was implemented lost an average of 1.2 g/dl less hemoglobin at 72 hours than the 202 patients for whom the created protocol was a control group ($p \leq 0.0001$), where it was demonstrated that the use of tranexamic acid in conjunction with other measures decreases the need for blood transfusions in the pre- and post-operative protocol, which reduces bleeding in patients.

In the specialty of plastic, aesthetic and reconstructive surgery, despite the fact that different procedures, such as breast surgery, abdominoplasty and liposuction produce important blood loss and may require transfusion in some cases, the use of ATX has been little studied despite its benefits that are presumed in the reports (Carrascal Carrasquilla, H. A. 2020). In terms of benefits, treatment with Tranexamic Acid offers an excellent recovery rate, with fewer complications, mortality and sequelae, also allowing to decrease the time spent in hospital (Piamo Morales, Alberto J., & Rojas, Mayra A. 2018).

In research conducted by Brown, S., Brown, T., & Rohrich, R. J. (2024) talk about the different interventions of craniofacial, aesthetic, facial surgery (rhinoplasty, rhytidectomy, blepharoplasty), breast reconstruction and in burn care to reduce blood loss, points out that objective and standardized measurements are required to obtain quantitative conclusions about the effects of TXA on ecchymosis and edema in plastic, aesthetic and reconstructive surgery procedures.

In plastic surgery, blood loss associated with surgical procedures can lead to various complications. Therefore, minimizing perioperative bleeding is critical to improving overall survival. Several interventions have been shown to effectively reduce surgical

bleeding, including the use of an antifibrinolytic agent (Scarafoni, E. E. E., 2021).

In summary, this systematic review identified discrepancies in the protocols for dosage, administration, benefits, and possible risks associated with tranexamic acid, which is the basis for its variable application. While some authors address aspects related to bleeding, hematomas, and complications, others discuss its efficacy, and still others focus on individual and personalized considerations for each patient.

II. Materials and methods

The research was conducted from a systematic review of the literature related to tranexamic acid used in plastic surgery through PubMed, ScienceDirect, Dialnet, SciELO, Google Scholar, Concytec, Cochrane, Conamed and MedlinePlus, this study was considered from the period of 2018 to 2024, with a total of 100 studies reviewed, within which 60 works that did not meet the search period established for this research were discarded, others that were not specific to plastic, aesthetic and reconstructive surgery; only 40 research articles were considered, which were searched in Spanish and English with search engines tranexamic acid applied in plastic surgery, tranexamic acid as a method of blood saving, effectiveness of treatment with tranexamic acid in bleeding, perioperative and postoperative tranexamic acid in plastic surgery.

The bibliographic search was systematic and of meta-analysis where the data related to tranexamic acid were analyzed, taking into account its effectiveness, reactions, routes of administration, indications, contraindications in the patient submitted to a surgical surgery, from the review of the scientific literature, which allowed obtaining relevant data to fulfill the objective of this research.

The study population in this literature review emerges in patients undergoing plastic surgery procedures, using the application of ATX who participated in the universe of samples concentrated in the most recent trends on the use of tranexamic acid.

III. Discussion of Results

Twenty controlled clinical studies were identified between 2018 and 2024 which evaluated the use and application of tranexamic acid specifically plastic, aesthetic and reconstructive surgery, where primary studies were included whose population or sample comprised patients with blepharoplasty surgery, rhinoplasty, rhytidectomy, breast reconstruction, burns, general plastic surgery and major surgery. The most frequent routes of administration were intravenous and topical, where there is a notable and increasing trend for the latter, in addition to the oral route being considered by some ATX studies. Doses vary significantly according to the route of administration, intravenous and oral doses are substantially higher to achieve systemic antifibrinolytic levels, while the topical dose is lower, because it seeks high local concentrations at the surgical site. The doses used ranged from no more than 500 mg and from 1 to 2 g per intervention; the studies evidenced the lack of protocols of consensus. However, Ausen, K., et al. (2022) point out that practice is needed in the evolution, instead of a fixed consensus, because the application may vary according to the type of surgical intervention, because the dose is not unique or universally standardized for all plastic surgery procedures, due to the fact that there is variability both in dose and in the route of administration.

ATX was discovered in the early 1960s by Shosuke and Utako Okamoto, motivated by the search for a new antifibrinolytic more potent than aminocaproic acid, clinically useful in postpartum hemorrhage. In addition, they point out that in 2009 the World Health Organization (WHO) included in the list of essential drugs for use in cardiac surgical procedures requiring cardiopulmonary bypasses to reduce deaths or fatalities (Carrascal Carrasquilla, H. A. 2020).

In a research conducted by Wheeler, D. R., Bucci, F., Vaccari, S., di Giuli, R., Vinci, V., & Klinger, M. (2023) show the benefits of the application of ATX in plastic surgery in which they point out that it reduces bleeding, reduces hematomas and swelling, adding that the complications that exist are associated with a slight delay in the healing of the postauricular skin, temporary unilateral marginal mandibular neuropraxia and increase of the accumulated volume in seroma.

According to Habarth-Morales, T. E., Isch, E., Zavitsanos, A. P., Wride, W. M., Davis, H. D., Rios-Diaz, A. J., Broach, R. B., Fischer, J. P., Serletti, J. M., and Azoury, S. C., In the study by & Jenkins, M. (2024), the application of tranexamic acid was found to reduce intraoperative and postoperative bleeding, as well as minimize postoperative swelling and bruising. The medication can be administered intravenously or topically during surgery, with minimal side effects.

It was also found that, according to the literature review, some studies focus on the fact that ATX in its route of administration can be intravenous, oral and topical, in such a way that in all routes it provides a faster recovery and also reduces the risk of postoperative complications in the patient.

In studies by AlGhanim, K., Al-Youha, S., AlWazzan, A., & AlHamad, S. (2021) indicate that TXA blocks plasminogen to plasmin activation by competitive inhibition of tissue plasminogen activators through binding to plasminogen lysine binding sites, thereby blocking degradation of fibrin polymers. In addition, TXA inhibits plasmin and fibrin preventing blood coagulation formation. According to research by Meretsky, C. R., Polychronis, A., & Schiuma, A. T. (2024) increasing interest in plastic, aesthetic and reconstructive procedures, blood loss has compromised patient safety and satisfaction. TXA is a drug used to reduce blood loss during surgical procedures.

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The utilization of ATX in plastic surgery has the potential to reduce perioperative bleeding, enhance surgical precision, and expedite the removal of drains. However, a comprehensive analysis of the benefits and risks associated with its use in plastic surgery indicates the necessity for additional randomized controlled studies to ascertain its efficacy in this context (Isaev, R., Frey, E., Motamedi, M., & Allert, S., 2023).

Notwithstanding these benefits, the standardization of the dosage and route of administration of ATX in plastic surgery remains a topic of discussion. A review of the extant literature reveals significant variability in clinical dosage. This finding suggests a need for additional studies to establish clear criteria, guidelines, and processes for its application to achieve its effectiveness in surgical intervention.

As illustrated in Figure 1, the mechanism of action of tranexamic acid involves the following steps.

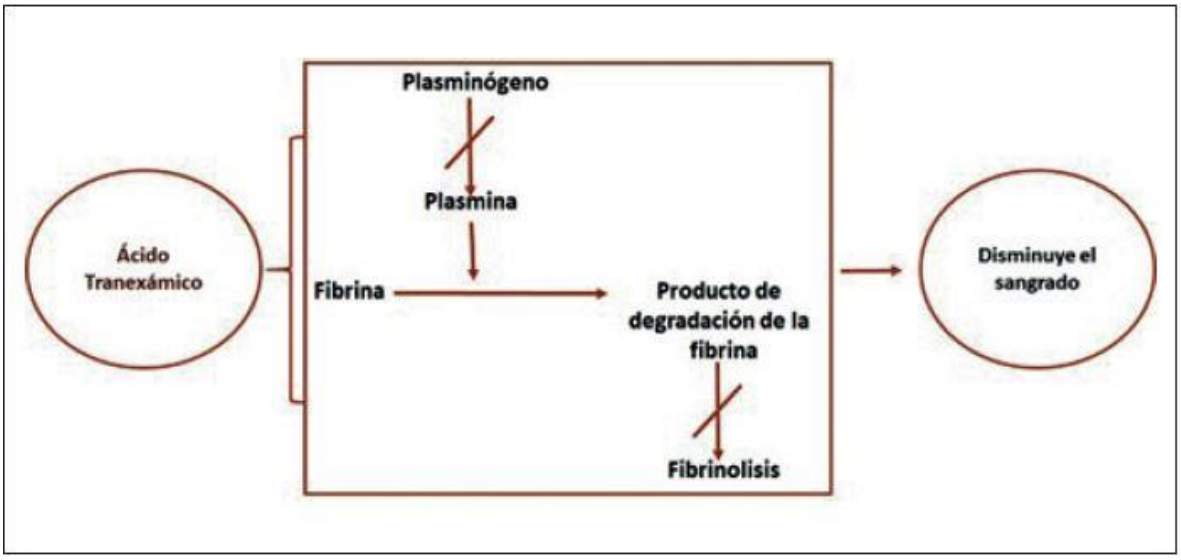


Figure 1. Representative diagram of the mechanism of action.
Source: Data from Tamayo-Carbón, C. A. M., Cuastumal-Figueroa, D. K., Tamayo-Carbón, A. M., & Iribarren, R. 2022.

In a research conducted in 2018, it was evidenced that, by reduction of plasmin activity, achieved with tranexamic acid, it is useful in conditions of high local and systemic fibrinolytic activity, as well as in most coagulation disorders in which there is clot formation with an abnormal fibrin network due to decreased and delayed thrombin generation (García TJI, González-Cantú G, González- Robles A, et al. 2018).

In this context, another research talks about a strategy to decrease the amount of blood loss and reduce the risk of transfusion is the use of antifibrinolytic medication, it is given from tranexamic acid (ATX). The results of published studies in hip arthroplasty, knee arthroplasty and other surgeries indicate that the application of ATX significantly reduces blood loss and the number of patients transfused (Piaget et al., 2001).

Perioperative use of ATX has become popular among plastic surgeons for various surgical procedures, perioperative intravenous administration of TXA significantly reduced the risk of hematoma (7.3% vs. 12.9%; OR, 0.43; CI 0.23 to 0.81) and seroma formation (11.5% vs. 19.9%). (11.5% vs. 19.9%; OR, 0.57; 95% CI, 0.35 to 0.92) compared to the control group. In studies that measured the amount of postoperative drainage, the mean difference was 132 ml (95% CI, 220 to 44 ml). No thromboembolic events occurred in either group (Liechti, R., van de Wall, B. J. M., Hug, U., Fritsche, E., & Franchi, A., 2023).

Despite the benefits of ATX in plastic surgery is extremely limited, mainly because most plastic surgery procedures do not involve the magnitude of blood loss that can lead to anemia and the need for blood transfusion, in this sense minimizing blood loss during surgery is critical (Rohrich, R. J., & Cho, M.-J., 2018).

Safran, T., et al. (2023) state that excessive seroma/hematoma fluid accumulation around the breast implant after reconstruction can lead to significant complications, topical administration of ATX can reduce fluid accumulation and complications postoperative complications, representing an option to decrease complications in alloplastic breast reconstruction.

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ATX can reduce intraoperative and postoperative bleeding, Wokes, J. E., Erdmann, M. W., & McLean, N. R. (2021) state, in addition to minimizing postoperative swelling and ecchymosis, being administered both intravenously, and topically during surgery with minimal side effects that do not affect the patient's recovery. In a study conducted by Kolasiński, J., Reysner, T., Kolenda, M., Kołacz, S. and Domagalska, M. (2024) was applied of ATX systemic (MD -18.05, 95% Cl,− 22.01,− 14.09, p< 0.00001) and topical (MD− 74.93, 95% Cl,− 88.79, −61.07, p < 0.00001) tranexamic acid reduced total blood loss. Topical tranexamic acid reduced drainage expenditure (p < 0.0006); tranexamic acid reduced blood loss in cosmetic plastic surgery.

So also, surgeons who routinely use ATX reported reduced blood loss, improved surgical field, and reduced postoperative ecchymosis; 95.7% of ATX patients have never had ATX- related complications, on the contrary, in its extraordinary clinical benefits by minimizing perioperative blood loss, reduced postoperative ecchymosis and edema, and improved patient outcomes (Brown, S., Brown, T., & Tessone, A., 2020).

Although it is true that no standardized evidence has been found that relates the use of tranexamic acid with a significant increase in the risk of clot formation, however, it is advisable to analyze its dose in order to avoid adverse effects. In this sense, it is crucial that its indication is made after an individualized evaluation of each patient, considering their medical and clinical history as risk factors, which could influence their wellbeing and health.

Table 1 shows the application dose according to the indication, dosage and recommendation of tranexamic acid.

Table 1. Application dose of tranexamic acid in plastic surgery.

Route of administration	Dose	Recommendations
Intravenous	5 mg-10 mg	Before surgery.
	1000 mg	A second dose four hours after the first dose or at the end of surgery.
Oral	1000 mg-1250 mg	Three times daily starting five days before surgery.
	1300 mg	Three times a day for 5 days.
Topical	1-3 grams	Inject prior to surgery every 2 hours, or during recovery closure.

Source: Adapted from International Society of Plastic and Aesthetic Nurses, retrieved from: https://ispan.org/newsletters/2020-February.cgi?s=open&aID=article6.

Hernández Díaz, J. L. (2022) applied a test of reaction to tranexamic acid to a sample of 20 patients undergoing eyelid surgery in his research. In each patient, he utilized an intraoperative solution comprising 1 ml of tranexamic acid (100 mg/ml), along with 4 ml of lidocaine (2%), 4 ml of bupivacaine (0.5%), and 1 ml of adrenaline (1 mg/ml) in the right eye, and a solution of 4 ml of lidocaine (2%), 4 ml of bupivacaine (0.5%), and 1 ml of adrenaline (1 mg/ml) in the left eye. No complications were observed in any of the cases.

In addition, Palmieri-Bouchan RB, Aguirre-Rodriguez VH, Salinas-Vela LE, et al. (2020) report that 31 patients undergoing primary reverse arthroplasty participated in two groups: group A (17 patients) were given 1 g intravenous tranexamic acid preoperatively and group B (14 patients) were not given tranexamic acid. Hemoglobin and hematocrit preoperatively and at 24 hours after surgery were recorded, as well as bleeding quantified in the drainage at 24 hours, and blood transfusion requirements. In this population there is a tendency to less bleeding in the surgical drainage in patients with patients with ATXM (115.6 vs 162.65 ml, p = 0.0768), in the decrease of hemoglobin (2.16 vs 2.79 g/dl, p = 0.1257) and hematocrit (6.67% vs 7.95% p = 0.3431).

Rojas Yepes, M. A. (2019), through the American Society of Plastic Surgeons, reported that 121, 531 rhytidectomies were performed in 2018, making facelift one of the most popular cosmetic surgery procedures. It further notes that hematoma is the most frequent early post-operative complication, with most occurring in the first 12 to 24 hours after your procedure.

Barbero, P. G., Aparicio, M. G., Dobón, J. B., de Tomás, J. P., Suárez-Varela, M. M., & Pérez, J. R. (2019), in their research selected 78 patients, 31 with intravenous and 47 with intra-articular treatment, the intravenous group lost an average of 1,505 ml of blood vs. 11,280 ml of the intra-articular group. Transfusions were necessary in 5.1% of the cases; no secondary complications were obtained.

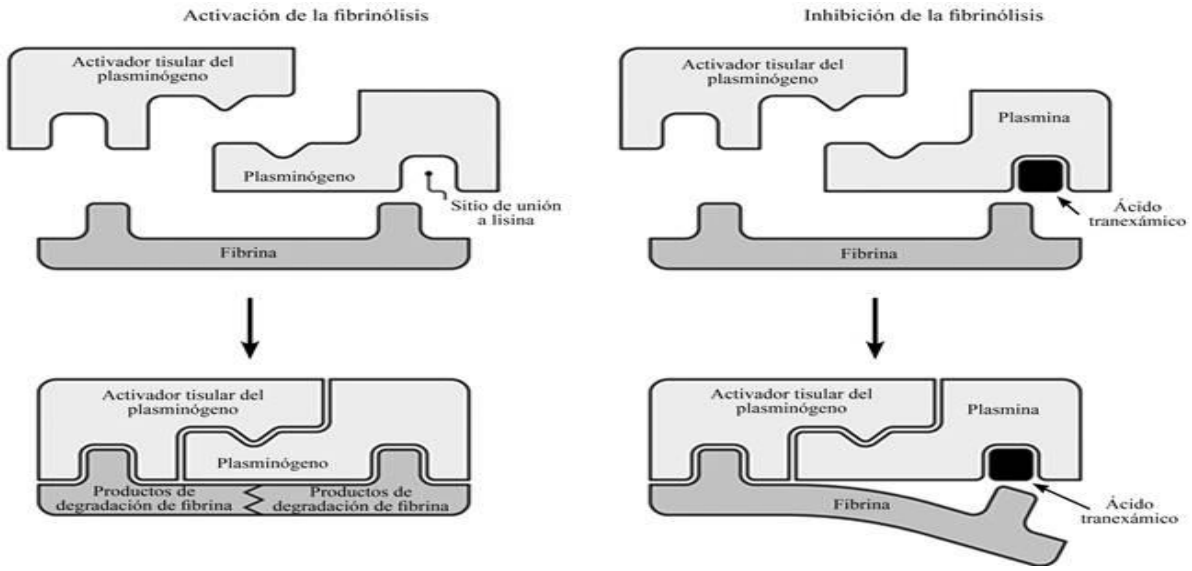


Figure 2. Mechanism of action of tranexamic acid.
Source: Retrieved from https://www.medigraphic.com/cgi-bin/new/resumen.cgi?IDARTICULO=105708.

In another study performed in Merida Yucatan, by the surgical team in the application of the tranexamic acid drug, they concluded that patients were assigned to one of three groups: Intravenous group (group 1): received one 500 mg ampoule of tranexamic acid diluted in 100 ml before incision and another during closure; Oral group (group 2): received three 650 mg (1,950 mg) tablets of oral tranexamic acid two hours before incision and Control group (group 3): did not receive tranexamic acid. In terms of postoperative blood loss, data of 229.302 ml were observed for group 1, 303.125 ml for group 2 and 421.429 ml for group 3 (Gomez, E. E. V., et al. 2024).

In general, the authors speak of plastic, aesthetic and reconstructive surgery, in which it is established that, despite the diversity of procedures such as breast surgeries, abdominoplasty and liposuction produce significant blood loss and may require transfusion in some cases, the use of ATX has been little studied despite its known benefits (Carrascal Carrasquilla, H. A. 2020).

3.1. Comparison with other surgical interventions.

Early administration of ATX after diagnosis of postpartum hemorrhage decreases mortality from bleeding. Based on this study, the World Health Organization recommends the administration of tranexamic acid to all women with postpartum hemorrhage, 1 g of tranexamic acid is recommended to be administered within 3 hours of birth to all women with postpartum hemorrhage regardless of the cause. Preventive use of the drug should be considered in patients who are at high risk for hemorrhage and who must undergo cesarean section (Prozzi, G. R., Marinchevich, M. A. M. M., Carlson, M. S., & Prozzi, G. R. 2022).

Table 2 shows the possible risks that may be incurred depending on the type of surgery.

Table 2. Stratification of hemorrhagic risk according to type of surgery.

Hemorrhagic risk	Type of surgery
Low	Minor surgery: peripheral, plastic, orthopedic, dermatological, otorhinolaryngological, endoscopic, anterior chamber of the eye and dental procedures.
Moderate	Major visceral surgery, cardiovascular, major orthopedic, tonsillectomy, reconstructive plastic surgery, endoscopic urological surgery (for example, transurethral resection of prostate)
High	Intracranial neurosurgery, medullary canal and posterior chamber of the eye

Source: Extracted from Nazar J., Claudio, Contreras C., José Ignacio, Molina P., Ian, & Fuentes H., Ricardo, 2018.

The National Institute of Clinical Excellence (NICE) recommends the use of TXA in surgeries in which the estimated blood loss is greater than 500 ml, although the expected bleeding volume in bariatric surgery does not reach such values, bleeding remains one of the most feared complications in the postoperative period and leads to high morbidity (Deganutti, L., Sosa, M., Castellaro, P., & Costa, L. 2024).

Since 1988, a dose of 0.75 to 1.5 mg per day was indicated as the treatment for melasma and, at present, it continues to be one of the treatments for melasma. Its mechanism of action is based on the inhibition of plasminogen binding to keratinocytes, which blocks the arachidonic acid and prostaglandin pathway, decreasing tyrosinase activity and melanogenesis (Santa-Cruz, F. J., Ortiz-Lobato, L., Sánchez, M. A. M., & Pedrero, M. L. P. 2019).

Tranexamic acid (TXA) is commonly used to control postoperative blood loss in total knee arthroplasty. To avoid the adverse effects associated with intravenous administration, topical use has been proposed as an alternative (López-Hualda, Á., Dauder-Gallego, C., Ferreño-Márquez, D., & Martínez-Martín, J. 2018).

One strategy to decrease the amount of blood loss and reduce the risk of transfusion is the use of antifibrinolytic medication, is given from tranexamic acid (ATX). The results of published works in hip arthroplasty surgery, knee and other surgeries indicate that the application of ATX significantly decreases blood loss and the number of transfused patients (Piamo Morales, Alberto J., & Rojas, Mayra A. 2018).

3.2. Tranexamic acid compared to other bleeding control methods.

In a comparative study conducted on 92 patients of which 2000 mg of aminocaproic acid per dose was applied while 1300 mg of tranexamic acid per dose, administered orally, were evaluated 24, 48 and 72 hours, of which a trend of lower blood order was reported with the use of tranexamic acid and of aminocaproic acid higher bleeding, however, both drugs are considered good hemostatic agents (Morales Avalos, R. 2019).

3.3. Adverse effects of tranexamic acid.

Its use is associated with thrombosis, seizures, headache, back pain, abdominal pain, musculoskeletal pain, joint pain, muscle cramps, migraine, anemia and fatigue, as well as nausea, vomiting and diarrhea, hypotension and visual abnormalities have occasionally been reported, urethral obstructions due to clot formation have occasionally been described in patients with upper urinary tract hemorrhage, allergic skin reactions have been documented on rare occasions (Villeda, V. A. M., & Ramírez, L. D. L. 2021).

Table 3 shows the adverse reactions using tranexamic acid.

Tabl3 3. Adverse reactions in the application of tranexamic acid.

Organ system classification	Frequent (≥1/100 to <1/10)	Infrequent (≥1/1,000 to <1/100)	Frequency not known
Immune system disorders	No frequency recorded	No No frequency frequency recorded	Hypersensitivity reactions including anaphylaxis.
Nervous system disorders	No frequency recorded	No No frequency was No frequency recorded	Convulsions especially in case of improper use.
Eye disorders	No frequency recorded	No No occurrence was No occurrence recorded	Visual disturbances including deterioration of color vision.
Vascular disorders	No frequency recorded	No No frequency was No frequency recorded	Malaise with hypotension, with or without loss of consciousness (usually after too rapid intravenous injection, in exceptional cases after oral administration). Arterial or venous thrombosis at any site.
Gastrointestinal disorders	-Diarrhea - Vomiting Nausea	No available at No frequency recorded	No frequency recorded
Skin and subcutaneous tissue disorders	No frequency recorded	Allergic dermatitis	No frequency recorded

Source: Data from Fact Sheet of the Spanish Pharmacovigilance System for Medicinal Products for Human Use: www.notificaRAM.es.

3.4. Contraindications to tranexamic acid.

Contraindications for the use of the drug tranexamic acid include severe renal insufficiency, patients with acquired visual impairment, history of thrombosis and risk of thrombosis, so it is important to thoroughly investigate the patient's medical history prior to administering the drug to avoid possible complications (Villeda, V. A. M., & Ramírez, L. D. L., 2021).

ATX, with a dose not exceeding 20 mg topically or intravenously, has been reported to reduce the risk of bleeding during and after surgical procedures, both in minor and major interventions, improving operative times and reducing complications that may occur in the surgical field (Armijos Idrovo, S. G., & Pacheco Carabajo, L. A. 2023).

Contraindications for the use of tranexamic acid are wide, such as cardiovascular diseases requiring antiaggregation or anticoagulation, history of thrombotic event in the last year, vascular device carriers, other diseases predisposing to thrombosis, cardiac or vascular surgery in the last 6 months, use of other pro- thrombotic drugs, hypersensitivity, pregnancy or lactation, despite its several contraindications not many complications have been reported (Lizana, J., Aliaga, N., & Basurco, A. 2021).

IV. Conclusions

Tranexamic acid in plastic surgery has had an impact because it reduces hemorrhages and hematomas, improving the recovery of the patient. In this research we identified that tranexamic acid has consolidated its role as a valuable resource, due to its ability to reduce bleeding and improve the patient's evolution. Its benefits include a reduced need for blood transfusions and early recovery for patients. Despite its advantages, the lack of consensus on dosage and route of administration prevents its standardized application in all procedures. Therefore, it is suggested the development of broader studies that allow defining precise clinical guidelines adapted to the diverse needs of plastic surgery and other surgeries, as well as focusing on evaluating the effects of ATX in groups of patients with

specific conditions and at the same time specifying the application dose in surgical procedures of greater complexity, since there are different requirements and variables that contribute to the decision making process for its application and dosage. Likewise, rigorous monitoring and adequate patient selection will be strategic points to maximize the benefits of its use and reduce adverse effects that cause serious health risks.

In future research, it is recommended to establish specific mechanisms of action for the application of tranexamic acid, standardizing the dose and route of administration under the supervision of pharmacology specialists, in coordination with drug regulatory agencies, this will allow optimizing surgical processes and guaranteeing an adequate use of this innovative drug, whose impact is the object of analysis in the present research due to the existing discussions of its application in plastic, aesthetic and reconstructive surgery.

In this sense, it is suggested the implementation of assisted communication and telemedicine tools for the integral clinical follow-up of the patient, from the preoperative phase until recovery. This will make it possible to have a detailed and updated medical record, facilitating an alternative technological assistance that the patient can access voluntarily through a digital platform, such as "Form Forms" to encourage patient- physician collaboration. Finally, we propose a specialized follow-up period of three months, in order to evaluate subtle or late adverse effects that may arise from reactions such as the appearance of ecchymosis and edema, thromboembolic risks, delayed healing, as well as contraindications such as renal failure, visual disturbances, migraine, anemia, fatigue, allergic skin reactions, hypersensitivity, among others, Both reactions and contraindications arise from the inadequate use of ATX application and in the follow-up phase it is intended to guarantee a continuous medical supervision that allows the improvement in recovery, obtaining measurements of real results of the patient, and at the same time that during the follow-up clinical and practical guidelines are established based on solid evidences that will be useful for future research specifically applied in plastic, aesthetic and reconstructive surgery.

Also in the follow-up we suggest blepharoplasty surgeries, rhinoplasty, rhytidectomy, breast reconstruction, burns, general plastic surgery, major surgery, the dose varies significantly depending on the route of administration and type of surgery; however to determine the dose that will work best involves first having the standardization of dosage that demonstrated efficacy in the results measured both preoperative and postoperative phase, we propose a dose that does not exceed 20 mg in topical-local application to achieve localized antifibrinolytic effects, minimizing systemic exposure and possible side effects, and to achieve localized antifibrinolytic effects, minimizing systemic exposure and possible side effects postoperative phase, we propose a dose that does not exceed 20 mg in topical-local application to achieve localized antifibrinolytic effects, minimizing systemic exposure and possible side effects, in the intravenous route 500 mg before the incision and 500 mg during closure and orally no more than 1300 mg.

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