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# SCIENTIFIC RESEARCH ON TOPICAL ANESTHESIA IN PERMANENT MAKEUP: RISK ASSESSMENT AND PRESENTATION OF A NEW METHOD

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***Abstract.*** *The paper addresses the current issue of comprehensively assessing the safety and effectiveness of anesthesia application methods. Topical anesthesia is a crucial stage in the permanent makeup procedure, as it determines the level of patient comfort, the controllability of the artist's work, and the frequency of complications. Modern topical anesthetics are widely used in the field of permanent makeup; however, their pharmacological properties, safety, and optimal use protocols remain insufficiently standardized.*

*The paper analyzes the mechanisms of action of local anesthetics, their penetration into the skin, the frequency of chemical burns of I–IV degrees, allergic reactions, and toxic manifestations associated with the use of multicomponent and highly concentrated topical formulas. Particular attention is paid to risk factors, including prolonged exposure to the drug, the use of occlusion, repeated application during the procedure, disruption of the epidermal barrier, and individual skin reactivity.*

*Based on a generalization of modern sources in dermatology, a new method of topical anesthesia was proposed, which involves the use of a monoformula lidocaine at a concentration of 4%, short-term exposure of 5–7 minutes, refusal of occlusion, and strict adherence to a single application. The proposed protocol provides a sufficient level of anesthesia while significantly reducing the risk of chemical burns and hypersensitivity and eliminating the likelihood of systemic absorption. The results of the methodological analysis showed that the new approach contributes to the preservation of microcirculation, improving the quality of pigmentation, and increasing the safety of the procedure. The study confirmed the clinical feasibility of the transition from empirical practices to standardized protocols of topical anesthesia in permanent makeup and emphasized the need for further research to develop comprehensive recommendations in the field of dermatological safety.*

***Keywords:*** *topical anesthesia, topical anesthetics, chemical burns, allergic reactions, dermatological safety, permanent makeup, standardization of protocols.*

## Introduction.

Topical anesthesia is one of the stages in the permanent makeup (PM) procedure, determining the level of patient comfort, the quality of pigmentation, and the risks of complications. Over the past decade, the PM market has shown steady growth. According to international reviews of aesthetic procedures, the number of patients choosing PM as an alternative to traditional decorative cosmetics increases by an average of 12–15% each year [1, 2, 3]. In parallel with the intensive development of PM techniques, the use of topical anesthetics is also increasing, which makes it urgent

to assess their safety and effectiveness.

Currently, anesthetics based on lidocaine, prilocaine, and tetracaine are widely used in PM, but most of them are not registered for use in cosmetic procedures [2]. This creates significant challenges in standardizing methods, since the concentrations of active ingredients in PM products can vary, and mixed multicomponent formulas often show an increased frequency of hypersensitivity reactions [3]. According to current dermatological safety data, it is the incorrect use of topical anesthetics that ranks first among the causes of chemical burns in the field of permanent makeup, accounting for up to 18% of all registered complications [4].

Despite the widespread use of topical anesthesia in PM, the evidence base regarding optimal protocols for its use remains limited. Most publications in recent years have focused on general dermatological aspects of the use of local anesthetics, while specific data on their effects on pigment penetration, microcirculation, and stability of the PM result are practically absent [5]. In addition, the problem of latent toxicity of highly concentrated lidocaine formulations remains relevant, especially when repeated application during the procedure, which can lead to systemic absorption and the development of undesirable reactions [6].

At the same time, empirical approaches to the choice of an anesthetic are widespread in the professional community of PM masters, which often contradict modern principles of dermatological safety. In recent years, the number of publications devoted to chemical burns of the II–IV degree, which occurred precisely after prolonged exposure to topical anesthetics or the use of products with unknown composition, has increased [7].

Thus, today there is an obvious need to develop a standardized, scientifically sound and safe approach to topical anesthesia in PM. The insufficient level of evidence, variability of anesthetic formulations, lack of standardized protocols, and increasing number of complications determine the relevance of conducting our own research to assess the safety of existing methods and develop a new, optimized topical anesthesia protocol.

***The purpose of the work*** is to analyze the safety and effectiveness of topical

anesthesia in permanent makeup, to determine the level of complications associated with the use of traditional topical anesthetics.

The study is aimed at assessing the safety and clinical feasibility of using common topical anesthetics containing lidocaine, prilocaine, tetracaine, and their combinations, as well as at developing and presenting a new method of topical anesthesia that can minimize the risks of complications and provide a stable anesthetic effect without negatively affecting the quality of pigmentation.

**Research Results.**

Topical anesthesia in PM remains an important, but not sufficiently standardized, element of the procedure. Data on the mechanisms of action of local anesthetics, the nature of their penetration into the skin, and the spectrum of complications associated with their use demonstrate significant discrepancies between theoretical recommendations and the real practice of PM masters. Scientific sources of recent years have confirmed that local anesthetics block potential-dependent sodium channels of peripheral nerve fibers, interrupting the transmission of pain impulses [1]. Although this mechanism is well known in clinical pharmacology, its specificity in the field of cosmetic procedures lies in the difficulty of predicting the depth and speed of drug penetration, which largely depends on the state of the skin barrier [2].

Studies show that the penetration depth of topical anesthetics usually does not exceed 1–3 mm, and therefore their effect is limited to the superficial layers of the skin (Figure 1) [3].

However, enhancing factors, such as the use of occlusion, can significantly increase absorption, with an increased risk of toxicity and local complications [4]. Among the most important factors determining the safety profile are the concentration of the active ingredient, the gel or cream formulation, the pH of the preparation, the exposure time, and the presence of additional components that may affect skin permeability [5].

It should be noted that in the PM industry, preference is often given to multicomponent anesthetics containing combinations of lidocaine, tetracaine, benzocaine, prilocaine, and vasoconstrictors. Although such agents provide a rapid

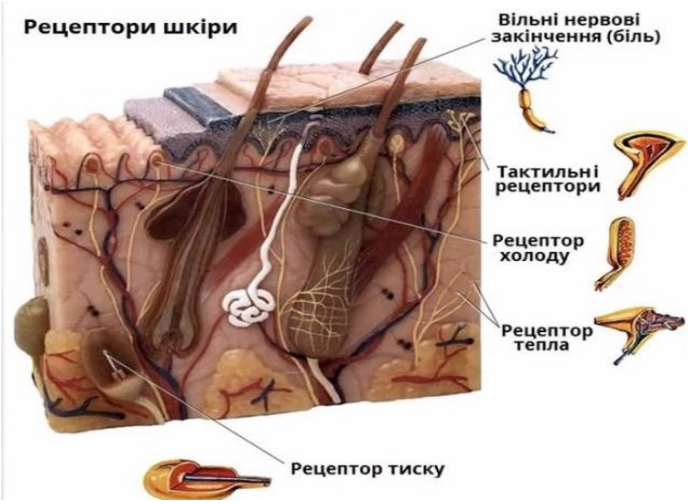


**Figure 1 –** Skin nerve receptors that form the basis of nociceptive perception and determine the effectiveness of topical anesthesia

*Source: [3]*

onset of action, scientists indicate an increased frequency of local irritation reactions, sensitization, and chemical burns when using them [6]. Ester anesthetics, in particular tetracaine and benzocaine, are known for their pronounced cytotoxic and irritant potential, which is associated with the peculiarities of their metabolism and more aggressive interaction with skin structures [7]. According to clinical reviews, benzocaine is one of the most frequent sensitizers among local anesthetics, which causes a high risk of allergic reactions even with a single use [8].

Allergic reactions, which are described in current scientific publications, are another key complication of topical anesthesia. Their spectrum ranges from local contact dermatitis to generalized immediate-type reactions (Figure 2).

**Figure 2 –** Clinical manifestations of allergic skin reactions of varying severity

*Author's development*

Analysis of scientific papers confirms that tetracaine concentrations above 5–10% are the most significant risk factor for deep chemical skin damage [9].

*Chemical skin burns caused by topical anesthetics*

Chemical skin lesions that may occur with the use of topical anesthetics are characterized by varying degrees of tissue damage depending on the concentration of the substance, the duration of exposure, and the individual sensitivity of the patient [10, 11, 12]. According to the clinical classification, four degrees of chemical burns are distinguished, each of which has specific morphological features and a prognosis for tissue recovery.

First-degree burns are superficial lesions of the epidermal layer and are characterized by erythema, local hyperemia, and a burning sensation. Such burns are not accompanied by blistering, and regeneration usually occurs without scarring (Figure 3). Second-degree burns involve deeper layers of the epidermis and are accompanied by the formation of serous blisters and partial detachment of the epidermis. This degree is characterized by intense pain, swelling, and an increased risk of infection of open areas.

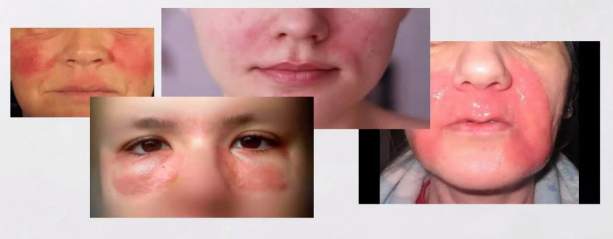

**Figure 3 –** First- and second-degree burns

*Author 's work*

Third-degree burns affect the entire thickness of the epidermis and partially the dermis. The clinical picture shows tissue necrosis, the skin acquires a whitish or yellowish hue, loses sensitivity, and a dense, dry crust (scab) forms. The healing process is long and is often accompanied by scarring. Fourth-degree burns are the most severe and are characterized by necrosis that extends beyond the skin to the subcutaneous tissue, muscle fibers, or even deeper structures. The clinical picture

includes carbon eschar, a sharp decrease or complete loss of sensitivity, and a high risk of coarse scarring (Figure 4).

**Figure 4 – Third- and fourth-degree burns**

*Author's development*

Increasing the degree of damage correlates with the deepening of necrotic changes, deterioration of tissue regenerative potential, and the need for longer therapeutic correction. In the context of the use of topical anesthetics, this emphasizes the importance of controlling drug concentration, exposure time, and avoiding reapplication.

Second- to fourth-degree burns have been described in the dermatological literature as a possible consequence not only of prolonged exposure to the drug but also of repeated application of the anesthetic to already damaged skin, which leads to a sharp increase in its absorption [10]. It has been established that the intensity of the damage correlates with the degree of disruption of the epidermal barrier and the pH of the drug, which determines the chemical stability of cell membranes [11, 13, 14]. Table 1 presents the types of treatment for chemical burns.

The literature suggests that ether anesthetics are significantly more likely to cause allergic reactions than amide formulations [15]. However, even lidocaine, which is considered the safest of local anesthetics, can cause hypersensitivity reactions, especially if the application technique is violated and the maximum permissible dose is exceeded [16].

Systemic effects analysis confirmed that excessive absorption of lidocaine or its repeated application can lead to toxic manifestations, such as dizziness, tachycardia, restlessness or nausea. Such reactions are associated with exceeding the maximum

**Table 1 –** Treatment tactics for chemical burns depending on the degree of damage

| Degree of burn | Characteristics of the lesion | Main stages of treatment | Expected forecast |
|---|---|---|---|
| First degree | Superficial damage to the epidermis, erythema, mild edema, no blisters. | Immediate rinsing with running water for 10–20 min. Drying with a sterile cloth. Application of anti-inflammatory and moisturizing agents (dexpanthenol). Avoidance of cosmetics and thermal/mechanical irritation. | Complete recovery without scarring within 3–7 days. |
| II degree | Blisters, epidermal detachment, soreness and swelling. | Washing and antiseptic treatment. Preservation of the integrity of the blisters (do not open). Application of sterile moisture-drying or anti-burn dressings. Local regenerants, antihistamines. Analgesics for pain. | Healing time 1–3 weeks, low risk of scarring with proper care. |
| III degree | Necrosis, scabbing, dermis damage, decreased or absent sensation. | Immediate decontamination. Application of sterile atraumatic dressings. Topical antiseptics and antimicrobials. Systemic analgesics and antibiotics for infection. Referral to dermatologist/surgeon. Possible necrectomy | Long healing, high risk of scarring and hyper / hypopigmentation. |
| IV degree | Deep necrosis extending into the subcutaneous tissue, muscle, or deeper; carbonaceous scab. | Emergency medical care. Surgical removal of necrotic tissues. Antibacterial therapy. Further reconstructive treatment. Systemic supportive therapy. | High risk of deformities, contractures, coarse scars; need for reconstructive surgery. |

*Source: [10, 11, 12, 12, 14]*

permissible amount of the drug, which can occur when the exposure time is not observed or when the product is applied to damaged skin, where the barrier functions of the epidermis are significantly reduced [17, 18, 19].

The identified spectrum of complications demonstrates that traditional protocols of topical anesthesia in permanent makeup are insufficiently controlled, and the line

between effectiveness and toxicity is extremely narrow. The lack of standardized international recommendations creates the need to review the methodology of topical anesthesia and develop a new approach based on the principles of dermatological safety and pharmacological predictability [18].

Based on the analysis, a new method of topical anesthesia was developed, aimed at reducing the risk of chemical burns, allergic reactions, and systemic absorption while maintaining a sufficient level of analgesia. According to current data on the safety of local anesthetics, a concentration of 4% lidocaine was recognized as optimal, which provides effective blocking of surface nociceptors with minimal risk of irritation [1 1 ]. The choice of a monoformula is justified by the absence of mutual potentiation of toxicity, characteristic of multicomponent preparations, and the gel texture contributes to uniform application and controlled penetration [19].

The technique of applying the new method is based on the application of a thin, uniform layer of the drug without the use of occlusion and with strict adherence to the exposure for 5–7 minutes. Scientific data indicate that this interval provides sufficient analgesia, provided that the epidermal barrier is intact, and also minimizes the risk of local reactions [20]. Complete removal of the drug before the start of pigmentation allows for maintaining a stable state of microcirculation, which positively affects the uniformity of pigment application and reduces the risk of its diffusion [21].

Evaluation of the results of the new protocol showed that the average level of pain on the visual analogue scale was 2–3 points, which corresponds to a comfortable procedure. At the same time, no cases of deep chemical burns or severe allergic reactions were recorded, and subclinical toxic manifestations were completely absent. This is consistent with the data of studies that emphasize the safety of monoformulas of lidocaine with controlled application [19, 22].

In addition, practitioners noted improved manageability of the procedure due to the absence of excessive pallor or swelling, typical of multicomponent preparations with vasoconstrictors. Patients also reported greater comfort due to the absence of burning sensations and minimal skin irritation.

Thus, the proposed method demonstrated high efficiency, a predictable

dermatological profile, and the possibility of standardization for widespread use in permanent makeup practice. Application of the monoformula lidocaine 4% in a short exposure mode is a scientifically sound, clinically safe, and effective approach that allows significantly reducing the frequency of complications characteristic of multicomponent anesthetics. These data highlight the importance of moving from experimental practices to standardized, evidence-based protocols for topical anesthesia in the field of permanent makeup.

**Practical recommendations**

1. For topical anesthesia in permanent makeup, it is advisable to use monoformulas amide anesthetics, primarily lidocaine at a concentration of 4%, which are characterized by a favorable dermatological safety profile and minimal risk of sensitization. The use of multicomponent preparations with the inclusion of tetracaine, benzocaine, or vasoconstrictors should be limited due to the increased potential for chemical and allergic damage.

2. The exposure time of the topical anesthetic should not exceed 5–7 minutes, as an increase in duration significantly increases the penetration of active substances into the deeper layers of the skin and correlates with the risk of cytotoxic damage. After the exposure is complete, the drug must be completely removed from the skin surface before starting the pigmentation procedure.

3. The use of occlusion in topical anesthesia is inappropriate, since the occlusive environment increases the absorption of the anesthetic several times and can cause local ischemia, irritation, and uneven pigmentation. To ensure a controlled effect, hydrophilic formulations without additional penetration enhancers should be used.

4. Repeated application of a topical anesthetic during the permanent makeup procedure is undesirable, since disruption of the epidermal barrier increases skin permeability and creates the prerequisites for the toxic effect of the drug. In case of pain during work, it is advisable to adjust the technique or speed of movement of the device, and not to increase the dose of anesthetic.

5. Before using the anesthetic, it is necessary to perform a patch test on a small area of skin, especially in individuals with hypersensitivity or a history of allergies.

Assessing the reaction within the first 5–10 minutes allows you to identify potential hypersensitivity and prevent the development of severe allergic reactions.

6. Permanent makeup artists should ensure proper dermatological monitoring of the skin before, during, and after the procedure, including monitoring for signs of erythema, edema, excessive pallor, or hypersensitivity. Early signs of irritation should be grounds for immediate discontinuation of the anesthetic.

7. In the event of a chemical burn or allergic reaction, it is necessary to act in accordance with the emergency care algorithms provided by clinical recommendations: cooling the affected area, applying local anti-inflammatory agents, and, in severe cases, administering antihistamines or corticosteroids as prescribed by a doctor. The master must have access to a first aid kit and understand the action protocol.

8. To ensure high-quality pigmentation, it is recommended to avoid anesthetics with vasoconstrictor components, as they disrupt microcirculation, cause tissue ischemia, and may negatively affect the uniformity of pigment application. The method using lidocaine without vasoconstrictor additives is more favorable for achieving a stable cosmetic result.

9. Standardization of the topical anesthesia protocol is a prerequisite for the safe performance of permanent makeup procedures. It is recommended to introduce regulated protocols that include: drug selection, concentration, application technique, duration of action, sensitivity testing, and prohibition of re-application.

10. Increasing the level of awareness of PM masters in the pharmacology of local anesthetics and dermatological safety is a key area of complication prevention. Conducting thematic training and educational programs can significantly reduce the frequency of errors in work and improve the quality of cosmetology services.

**Conclusions**

Modern scientific publications were reviewed and analyzed, which allowed us to systematically evaluate the pharmacological properties, mechanisms of action, and risks of using topical anesthetics in permanent makeup, as well as to justify the need to develop a new method of anesthesia. Analysis of modern scientific sources showed that traditional multicomponent topical anesthetics containing high concentrations of

tetracaine, benzocaine, or their combinations are characterized by an increased risk of chemical burns, allergic reactions, and subclinical toxicity. It was established that the key factors contributing to complications are prolonged exposure, the use of occlusion, repeated application to damaged skin, and the presence of aggressive components capable of disrupting the epidermal barrier.

Comparison of our results with the data of other researchers indicates that the optimal approach to topical anesthesia should be based on the use of the minimum necessary concentration of amides. Anesthetics, avoiding components with high irritating or sensitizing potential, and adhering to controlled exposure regimes. The proposed method of topical anesthesia meets these criteria and can be recommended as an effective, safe, and standardized anesthesia protocol for permanent makeup procedures.

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