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REMOVAL AND CORRECTION OF PERMANENT LIP MAKEUP: APPLICATION OF LASER AND REMOVER + GENTLE METHODS WITHOUT SCARRING

Summary. *The article presents an analysis of current approaches to the removal and correction of permanent makeup (PM) of the lips, prioritizing atraumatic techniques and scar prevention. The need for this study is driven by the rapid expansion of the PM segment and, as a consequence, the increased demand for clinically safe and effective correction methods. The aim is to systematize and compare laser and chemical strategies for pigment elimination and to formulate evidence-based recommendations for the use of gentle technologies. The methodological basis includes a systematic review and comparative analysis of peer-reviewed publications. The data obtained indicate a pronounced superiority of picosecond lasers over nanosecond (Q-switched) systems in terms of efficacy and safety profile, especially when acting on multicomponent color pigments. At the same time, the study demonstrated that chemical removers are associated with an inherently high and poorly predictable risk of forming atrophic and hypertrophic scars. A conclusion is drawn regarding the critical importance of interdisciplinary collaboration among PM specialists, dermatologists, and plastic surgeons to achieve optimal clinical and psychological outcomes. The material is addressed to professionals in aesthetic medicine, dermatocosmetology, and certified permanent makeup practitioners.*

Key words: *permanent lip makeup, tattoo removal, laser removal, chemical*

remover, picosecond laser, Q-switched laser, scar prevention, aging skin.

Introduction. The permanent makeup industry has exhibited exponential dynamics in recent years and has moved beyond a narrowly specialized service, becoming a segment of the global beauty market. According to 2024 analytics, the aggregate revenue of the global permanent makeup (PM) market is estimated at 152,4 million USD, with a projected increase to 277,8 million by 2032 [1]. In parallel, the tattoo and PM removal sector is rapidly scaling: in 2024 its volume reached 1,13 billion USD, and by 2032 it is expected to expand to 3,57 billion at a compound annual rate of 15,60% [3]. This multidirectional expansion simultaneously increases the clinical demand for effective and, fundamentally, safe technologies for PM correction and removal. The growth in the number of procedures is logically accompanied by a rise in the share of unsatisfactory outcomes, both due to insufficient practitioner competence and to shifts in patients' aesthetic preferences, which elevates the development of standardized correction protocols to a priority task of aesthetic medicine [2; 4].

The research problem is associated with a deficit of systematized, validated comparative data on the safety profile of various approaches to PM removal, especially with respect to the thin, delicate, and well-vascularized skin of the lips. Available publications examine in detail the efficacy of laser and chemical techniques [6], yet they insufficiently address the issue of irreversible histological consequences, primarily fibrosis and scarring. Accumulated observations indicate an elevated risk of complications when using non-laser technologies and, in particular, a direct threat of scar formation with the use of chemical removers [9; 11]. At the same time, structured protocols that minimize these risks in vulnerable patient categories, including individuals with sensitive or aging skin, remain underdeveloped.

The aim of the study is to systematize and comparatively analyze modern laser and chemical methods for removal and correction of lip PM with an emphasis on assessing their safety and to formulate scientifically grounded recommendations for the use of atraumatic techniques aimed at reducing the probability of scarring.

The scientific novelty lies in an integrated evaluation of the scarring risk profile in lip PM removal, for the first time combining data on the biophysical mechanisms of laser exposure, the histological effects of chemical destruction, and the clinical-practical nuances of managing patients with sensitive and aging skin.

The working hypothesis posits that an interdisciplinary strategy that unites the precision capabilities of modern laser technologies with an in-depth understanding of skin physiology makes it possible to safely eliminate unwanted pigment, ultimately ensuring a meaningful improvement in patients' psychological well-being and quality of life.

Materials and methods. The methodological framework of the study was formed on the basis of a systematic review and comparative analysis of peer-reviewed scientific literature. The search strategy was implemented in leading academic indexes — PubMed, Scopus, and Web of Science. The body of works included clinical trials, meta-analyses, review publications, and case reports focusing on pigment removal technologies and their associated clinical outcomes.

Sources are structured into three blocks. First, clinical and experimental studies: peer-reviewed works that provide a detailed assessment of the efficacy and safety of laser and non-laser removal approaches and characterize histological changes in tissues after intervention. Second, review and theoretical articles: publications that establish the basis for understanding the principle of selective photothermolysis, the chemical nature of pigments, and the mechanisms of wound repair. Third, industry analytical reports: materials from leading analytical agencies used exclusively in the introduction to substantiate the socio-economic context and the relevance of the issues under consideration.

Results and discussion. The primary mechanism of laser pigment elimination is selective photothermolysis: high-energy light pulses of a precisely specified wavelength are delivered into the dermis and selectively absorbed by the target chromophore — pigment particles [18]. A critically important parameter is pulse duration: it must be shorter than the thermal relaxation time (TRT) of the pigment particle, which for tattoo pigments lies in the nanosecond–picosecond range. When this ratio is maintained, the energy is localized within the granule, causing its ultrafast heating, thermoelastic expansion, and the formation of an intense photoacoustic shock wave that mechanically fragments the pigment into smaller components [18]. The resulting microparticles are recognized by the immune system as foreign and are removed via natural pathways, predominantly through macrophage phagocytosis with subsequent clearance through the lymphatic system [18].

In clinical practice, two groups of sources are used for tattoo removal: nanosecond Q-switched (QS) lasers and more modern picosecond (PS) systems. Q-switched lasers generate pulses lasting a few nanoseconds (10^{-9} s), with a predominantly photothermal mechanism: rapid local heating leads to thermal destruction and fragmentation of the pigment [18]. However, the relatively longer pulse duration — compared with PS devices — promotes heat diffusion into the surrounding dermis and increases the risk of collateral damage, which may clinically manifest as hypo-/hyperpigmentation, blistering, and changes in skin texture [13, 22].

Picosecond lasers represent a qualitative technological leap: their pulse duration is measured in picoseconds (10^{-12} s), that is, roughly a thousand times shorter than in QS systems. Such ultrashort exposure shifts the prevailing mechanism from photothermal to photomechanical [14]. The energy is delivered so rapidly that thermal diffusion is minimal, and the powerful photoacoustic effect efficiently pulverizes the pigment into submicron dust with minimal heating of the surrounding tissues [13; 22]. According to clinical data, PS lasers provide more complete pigment disruption — especially of hard-to-remove blue and green shades — require fewer procedures, and are associated with a substantially lower incidence of adverse events (blistering, hypopigmentation) compared with QS devices [12].

For a visual comparison of the key parameters of both technologies, Table 1 is provided below.

Table 1

Comparative characteristics of Q-switched and picosecond lasers for permanent makeup removal

Parameter	Q-switched (nanosecond) lasers	Picosecond lasers
Pulse duration	5–50 ns	375–750 ps
Primary mechanism of action	Photothermal (with photoacoustic component)	Photomechanical (predominant)
Efficacy (black pigment)	High	Very high, faster lightening
Efficacy (red/orange)	Moderate to high (532 nm)	Very high, surpasses QS
Efficacy (blue/green)	Moderate	Significantly surpasses QS
Average number of sessions	6–15 or more	4–10, generally fewer than QS
Risk of adverse effects (hypopigmentation, blisters)	Moderate to high	Low to moderate, substantially lower than QS
Risk of scarring	Low (with proper protocol)	Very low (minimal thermal damage)
Pain sensations	Moderate to severe	Mild to moderate, generally better tolerated

Source: compiled by the author based on [7; 10; 12; 13; 26]

Chemical methods for pigment removal rely on a mechanism fundamentally different from laser technologies: instead of selective photothermal action on the chromophore, they implement nonselective chemical destruction of tissues with the induction of a controlled burn or marked inflammation, whereby the pigment is eliminated from the skin. By type of active agent, acidic compositions are distinguished, based on alpha-hydroxy acids —

glycolic, lactic, and others — which provide chemical exfoliation of the epidermis and dermis with destruction of pigment-containing cells; alkaline formulas based on, for example, sodium hydroxide, initiating saponification of tissue lipids, coagulative necrosis, and subsequent rejection of necrotized material together with the pigment; as well as salt-based techniques (salabrasion), where a hypertonic solution is introduced intradermally and, by creating an osmotic gradient, promotes the drawing out of interstitial fluid with pigment particles to the surface, often in combination with mechanical abrasion [9].

Despite differences in the chemical nature of the reagents, their biochemical logic is unified: introduction of the active substance into the dermis triggers an acute inflammatory response, leading to necrosis of pigment-containing cells and formation of a scab. In the reparative phase — from several days to weeks — the scab is rejected and mechanically carries fragments of pigment out of the focus [20]. The key problem of the method follows from its essentially traumatic and poorly predictable nature: unlike laser systems that allow fine calibration of parameters for atraumatic, targeted exposure, the depth of penetration of the chemical agent and the severity of the inflammatory response vary widely and depend on individual characteristics — skin thickness and type, and the state of the immune system. Since uncontrolled inflammation and chemically induced necrosis directly predispose to pathological scarring, the risk of hypertrophic and atrophic scars is not a random complication but an immanent property of this approach; this is confirmed by retrospective observations documenting a high frequency of irreversible cicatricial changes after the use of removers [11].

The effectiveness of removing permanent lip makeup when using chemical removers is heterogeneous and is determined by a combination of factors: the shade and chemical nature of the pigment, the depth of its deposition, and the patient's skin phototype.

Laser methods are characterized by high selectivity, with effectiveness strictly determined by the radiation wavelength. The 1064 nm range (Nd:YAG) is recognized as the most suitable for eliminating black and dark blue pigments: it provides deep penetration into dermal layers with minimal melanin absorption, which determines the best safety profile in patients with skin phototypes III–VI [18]. The 532 nm wavelength (KTP, frequency-doubled Nd:YAG) is selectively absorbed by red, orange, and violet dyes, and is therefore considered key in the correction of permanent lip makeup, but at the same time is intensely absorbed by melanin, increasing the risk of both hypo- and hyperpigmentation in individuals with dark skin. Alexandrite systems at 755 nm and ruby systems at 694 nm demonstrate high efficacy for green and blue shades; however, their use is also limited in patients with higher phototypes. Picosecond platforms have shown advantages when working with a wide palette, including difficult-to-remove blue and green tones, and they often surpass nanosecond modes in removing red pigments [12].

Removers, according to manufacturers' claims, are capable of acting on pigments of any color range, including beige, white, and yellow, which practically do not respond to lasers due to the absence of pronounced light absorption [8]. Their proposed mechanism is not associated with optical selectivity but with chemically induced tissue destruction. Nevertheless, the volume of reliable clinical data confirming not only the effectiveness but also the safety of such agents is substantially inferior to the rich evidence base accumulated for laser technologies (see Fig. 1).

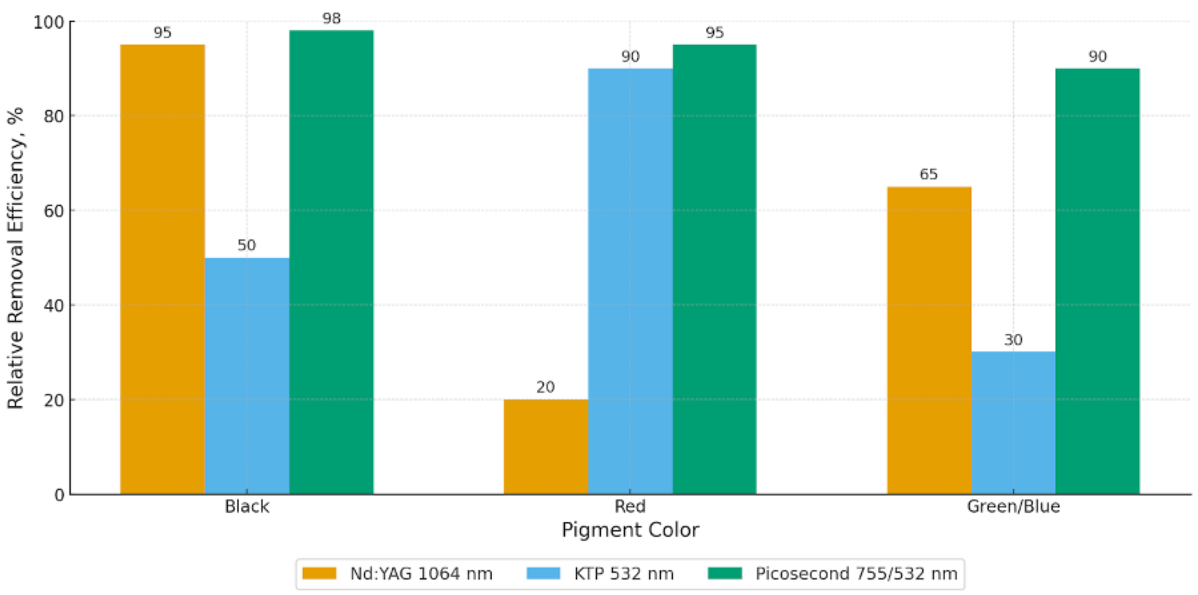

Fig. 1. Comparative efficiency of laser systems in relation to different pigment colors

Source: compiled by the author on the basis of [2-5; 24; 25]

The safety profile is the key criterion when choosing a method for removing PM. Regardless of technique, expected early reactions include pain syndrome, erythema, edema, and crust formation [17]. At the same time, the nature of specific complications differs substantially. Thus, laser-specific complications include:

- Dyspigmentation: Hypo- and hyperpigmentation remain the most common adverse outcomes, especially in patients with higher phototypes or with incorrect parameter settings. Picosecond systems are associated with a lower frequency of such events due to reduced thermal impact on melanocytes [13].

- Paradoxical darkening (Pigment Inversion): This is one of the most significant risks when working on the lips. It is characteristic of cosmetic pigments based on iron oxide ($Fe2O3$) or titanium dioxide ($TiO2$), which are widely used in lip formulations. Under laser exposure, a chemical reduction of these compounds can occur, causing an irreversible inversion of the pigment into a dark gray or black color. This reaction is unpredictable and underscores why performing a test patch before the full procedure is a mandatory step [17].

- Allergic reactions: Fragmentation of the encapsulated dye can lead to the release of antigenic material and trigger systemic hypersensitivity to previously inert components, especially to red pigments [17].

- Blister formation: An expected transient reaction caused by rapid gas formation in the dermal layers; severity is higher with QS lasers [18].

Practical experience dictates a cautious, staged laser protocol, especially with multi-colored or dark pigments. A common clinical strategy involves initiating treatment with one specific laser nozzle (e.g., targeting the primary color). The patient is then reassessed after a full healing cycle (approximately 6 weeks). A different nozzle or wavelength may then be employed to target residual dark shades. It is imperative to warn the client in advance about this multi-stage process and the potential for temporary color shifts, managing their expectations for a gradual, rather than immediate, result (fig.2).

Fig. 2. Clinical example of successful laser removal of pigment from the lips

As for complications of chemical methods, these include:

- Scarring: The most significant and often irreversible consequence. The nonselective tissue destruction underlying the method carries a high risk of both hypertrophic and atrophic scar formation [9]. In a retrospective series, 100% of patients seeking correction after chemical removal exhibited cicatricial changes (50% hypertrophic, 42% atrophic) [11].

- Infections: The prolonged presence of a wound surface and a zone of necrosis creates conditions for the addition of secondary bacterial flora [16].

- Chemical burns: Technical errors or individual reactivity can lead to deep, poorly controlled burn injuries [9].

Given these high risks, clinical practice suggests that in some cases where the laser is inappropriate, a chemical remover may be considered (e.g., for laser-resistant colors). However, it is critically ill-advised to treat the entire lip surface in one session. A safer protocol involves working in sections, treating no more than 50% of the lip area at a time. This partial treatment approach limits the total inflammatory load and significantly reduces the risk of extensive, uncontrolled scarring and excessive tissue trauma, allowing one area to heal before addressing the next.

Table 2 below will present a comparative analysis of the likelihood and severity of complications for laser and chemical removal methods.

Table 2

Risk matrix: Comparative analysis of the likelihood and severity of complications for laser and chemical removal methods

Complication	Lasers (picosecond)	Chemical removers
Hypertrophic/atrophic scarring	Likelihood: low Severity: high (with protocol violation)	Likelihood: high Severity: high (often irreversible)
Secondary infection	Likelihood: low Severity: moderate	Likelihood: moderate to high Severity:moderate to high
Allergic reaction	Likelihood: low Severity: high (systemic)	Likelihood: low to moderate Severity:high (contact dermatitis)
Hypo-/hyperpigmentation	Likelihood: moderate (depends on skin phototype) Severity: moderate (often transient)	Likelihood: high Severity: high (often persistent)

Severe pain / prolonged healing	Likelihood: lowSeverity: low	Likelihood: highSeverity: moderate to high

Source: compiled by the author based on [11; 15; 23; 25]

Work with patients from special clinical groups requires adaptation of standard protocols. These approaches, arising from practical observations, correlate with data from scientific publications.

Aging skin demonstrates thinning of the epidermis, collagen and elastin deficiency, and slowed repair, which increases its sensitivity to mechanical and thermal damage. Accordingly, the stated principle of a maximally superficial technique serves as a critical instrument for protecting weakened dermal structures. During the initial performance of PM and during its removal, the intervention should be limited to the minimally necessary depth so as not to injure the basement membrane and not to provoke excessive fibrogenesis.

Prevention of scarring essentially comes down to controlling the phases of wound healing. After laser exposure, an acute aseptic inflammatory reaction is initiated; macrophages infiltrate the treated area and clear pigment fragments [18]. Physiological recovery includes re-epithelialization and remodeling of dermal collagen without pathological hyperproliferation of fibroblasts. Excessive procedural aggressiveness or nonadherence to aftercare disrupts this balance, initiating disorganized collagen synthesis and the formation of scar tissue.

A strictly regulated postprocedural regimen is a key element of atraumatic patient management.

Photoprotection: complete avoidance of insolation of the treated area for at least 1.5 months is critically important for the prevention of postinflammatory hyperpigmentation [18].

Support of regeneration: systematic application of reparative agents (for example, preparations based on panthenol) accelerates epithelialization and maintains an optimally moist wound environment.

Prohibition of mechanical impact: removing forming crusts is categorically unacceptable; their premature detachment exposes immature epithelium, increasing the risk of injury and hypertrophic scarring.

Limitation of thermal loads: during the first 5–10 days one should refrain from baths, saunas, and intense physical activity with pronounced sweating in order to avoid maceration and delay of reparative processes.

In summary, it can be noted that the integration of permanent makeup into clinical practice in the format of medical micropigmentation constitutes a validated and effective tool for the correction of cicatricial changes and other aesthetic deformities. Such an interdisciplinary approach not only improves appearance but also exerts a pronounced positive influence on the psychological state and quality of life of patients.

Conclusion. The analysis performed makes it possible to formulate a set of fundamental propositions with high practical value for specialists in aesthetic medicine. Picosecond laser systems serve as the gold standard for the removal of permanent lip makeup: they provide an excellent clinical response across a broad range of pigments and are characterized by a substantially better safety profile compared with Q-switched technologies, which is reflected in minimal collateral thermal effects and a lower risk of postprocedural dyspigmentation and changes in skin texture.

Chemical removers cannot be regarded as a routine method in the lip area. Their nonselective, poorly controlled mechanism of action is associated with an inherently high risk of irreversible scarring. The use of such agents is acceptable only as an exception—in situations where laser methods are ineffective (for example, when elimination of white pigments is required)—and only after complete and comprehensible patient information about potential risks.

Atraumatic management regimens, especially in patients with aging or sensitive skin, should be based on principles of maximally superficial exposure, limitation or avoidance of topical anesthesia to preserve the operator's tactile control, and strict adherence to postprocedural care that ensures predictable management of reparative processes.

Thus, the objective of the study has been achieved. The practical significance of the work lies in providing specialists in aesthetic medicine with a comprehensive, evidence-based foundation for clinical decision-making. This makes it possible to prefer the safest and most effective strategies for the removal and correction of permanent makeup, to optimize protocols for complex clinical situations, and to consistently implement a focused approach to maximize clinical and psychological outcomes related to pigment removal.

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