Removal of failed permanent makeup: laser and non-laser methods, risks and prospects

Oleksandra Saburkina [1]

Received: 2025-09-07
Accepted: 2025-10-11
DOI: https://doi.org/10.5281/zenodo.17849889

Abstract. The article is devoted to the analysis of modern laser and non-laser methods of removing failed permanent makeup, their risks, effectiveness and potential development directions. The purpose of the article is to investigate methods of removing permanent tattoos using laser and non-laser methods. In the course of the scientific research, general scientific methods of cognition were used: analysis, synthesis, induction, deduction, comparison, classification, generalization, systematization of scientific sources. The results of the study show that in clinical practice the leading approach to removing failed permanent makeup is the use of Q-switched lasers. The main types of lasers, such as ruby (694 nm), Nd:YAG (1064 and 532 nm), are reviewed. It is shown that these systems are based on the photoacoustic effect, in which pigment particles are destroyed under the influence of short pulses with subsequent removal through the immune system. It is shown that fractional lasers (ablative and non-ablative) also have applications as additional or combined tools, especially when working with resistant areas. The effectiveness and dangers of non-laser methods, such as dermabrasion, salabrasion and chemical removal using trichloroacetic acid and phenol, are separately investigated. It is shown that prospects in this area are associated with the development of combined protocols that combine laser fragmentation of the pigment with subsequent purification (fractional, chemical or mechanical), as well as taking into account the nanoscale characteristics of dyes for more accurate selection of laser exposure parameters. The practical significance of the study lies in the generalization of the evidence base for choosing the optimal tactics for removing unsuccessful permanent makeup in clinical dermatology and aesthetic medicine.

Keywords: permanent makeup, Q-switched laser, dermabrasion, pigment, cosmetology.

[1] ORCID: https://orcid.org/0009-0008-0308-4541
Master's Degree in Marketing, Permanent Makeup Master and Trainer,
Kyiv National University of Trade and Economics, Ukraine

Introduction

Modern fashion trends in human appearance demonstrate a clear increase in demand for tattoo removal worldwide. If earlier tattoos were considered a permanent element of self-expression, now, with changing aesthetic standards, improving application techniques and increasing requirements for the quality of tattoo art, a significant part of people strive to get rid of outdated or unsuccessful works. This global trend is confirmed by statistics from different countries. In particular, data obtained in Saudi Arabia show that 58% of people with tattoos regret having them, and more than 66% intend to remove at least one of them. In addition, 42.5% have already made appropriate attempts. At the same time, 93.9% consider laser technology to be the most effective method of tattoo removal. This indicates that tattoo removal is not an isolated issue, but a massive global demand that is closely related to the development of aesthetic medicine and the growing awareness of patients regarding the possibilities of appearance correction [9].

Literature Review. The issue of removing unsuccessful permanent makeup, in particular using laser and non-laser methods, as well as assessing risks and prospects, is widely studied in foreign scientific literature. Publications on this topic are presented in leading international scientific journals, which indicates significant attention to the problem from the medical and cosmetology community around the world.

The largest body of research is devoted to laser tattoo removal, in particular the use of Q-switched lasers. In this context, the works of such authors as U. Ahčan et al. [1], who provided a thorough analysis of the effectiveness of Q-switched lasers, as well as T.S. Alster and J.R. Lupton [2], who made a general overview of the types of lasers in dermatology. A significant contribution to the study of the physicochemical properties of pigments and their response to laser radiation was made by W. Bäumler [3], E.F. Bernstein [4] and H. Hohman and M.L. Ramsey [6], S.L. Kilmer and R.R. Anderson [7], T. Kossida and colleagues [8].

In the field of non-laser methods, the work of G. Dash et al. [5] is important, where a modern approach to alternative methods of tattoo removal is presented. Additional information on patient perceptions, complications and decisions about removal can be found in the study of H. Mitwalli and N. Alfurayh [9], which has a socio-psychological emphasis.

Regarding the prospects for the development of methods for removing permanent makeup, publications that analyze the effectiveness of new technologies, such as pico- and nanosecond lasers, in particular in the study of M.W. Ong and S.J. Bashir [10] and V. Ross et al. [11].

The purpose of the article is to investigate methods of removing permanent tattoos using laser and non-laser methods. To achieve the goal, the following tasks will be performed during the study: the features, advantages and disadvantages of laser techniques, non-laser methods are considered, and the directions of development of technology for removing unsuccessful tattoos are reviewed.

Research Results

Permanent makeup, also known as cosmetic tattooing, is a minimally invasive procedure for introducing pigment into the upper layers of the dermis in order to correct or enhance natural features. During tattooing, significant amounts of pigments containing various chemicals, including impurities and residual synthesis products, are introduced into the skin. The main components are amorphous carbon (Carbon Black), which is used mainly for black pigments, as well as azo dyes and polycyclic pigments, which provide a variety of colors in the visible spectrum [3]. This process is accompanied by activation of the immune system and the launch of complex transport mechanisms in tissues. Currently, there is no data on the possible accumulation of tattoo pigments in other human organs, which necessitates further toxicological and clinical studies [3]. Due to these factors, the type of tattoo is changing, and the number of people who want to remove the remains is increasing every year.

However, due to improper selection of pigments, violation of the technique, asymmetry or undesirable color changes during the healing process, the final result may not meet the client's expectations. In such cases, there is a need for partial or complete removal of the pigment. Today, there are two directions of tattoo removal: laser and non-laser. Each direction has subspecies. Let's consider them.

In modern dermatological practice, the leading method of removing unsuccessful tattoos is the use of Q-switched lasers. This technology provides selective destruction of pigment particles without the formation of coarse scars, which is of significant importance for cosmetically significant areas of the skin. The principle of action is based on the photoacoustic effect: ultrashort and highly intense laser pulses are absorbed by pigment particles, causing their instant fragmentation [8]. The formed smaller particles undergo phagocytosis and lymphatic removal, i.e. elimination by the immune system. Due to this selectivity, the surrounding tissues remain practically unharmed. Today, there are dozens of types of such lasers, which are described in the study by Kilmer S.L., Anderson R.R. [7] with a review of the clinical use of the technique (Table 1.)

Table 1 - Main types of Q-switched lasers for tattoo removal

Type of laser	**Wavelength**	**Main target pigments**	**Key characteristic**
Q-switched ruby laser	694 nm	Blue, black, green	High efficiency for dark pigments; temporary pigment changes may occur
Q-switched Nd:YAG laser	1064 nm	Black	Low melanin absorption - reduced risk of hypopigmentation and thermal damage
Q-switched Nd:YAG laser	532 nm	Red and warm tones	High selectivity for red dyes; temporary skin depigmentation may occur

Note: systematized by the author based on research [7]

In clinical dermatology, Q-switched lasers are the leading technologies for tattoo removal, as they provide selective photoacoustic effects on the pigment with minimal damage to surrounding tissues. Their action is based on ultrashort high-power pulses that are absorbed by the dye and lead to its instant fragmentation with subsequent elimination by immune system cells. Among the systems used, the most common are the Q-switched ruby laser (694 nm), effective against blue, black and green pigments, and YAG lasers with a wavelength of 1064 nm for selective removal of black pigment with a low risk of post-procedural depigmentation. Additionally, the YAG laser with a wavelength of 532 nm is used, which shows high efficiency for red pigments. Accumulated research results show that reducing the pulse duration to the picosecond range increases the efficiency of pigment destruction, providing a deeper change in its optical characteristics and faster tattoo lightening, which determines the prospects of picosecond systems as a direction for further development of laser technologies in pigment removal [11].

The use of Q-switched lasers is considered the gold standard for tattoo removal due to the combination of high efficiency and safety. The method provides a controlled and selective effect on the pigment, reduces the risk of scar formation and gives good aesthetic results.

In modern tattoo removal protocols, not only the choice of the type of Q-switched laser is important, but also the optimization of its parameters in accordance with the physical properties of light and interaction with tissues [1]. Since the melanin of the epidermis actively absorbs short-wave radiation, it is recommended to use longer wavelengths for patients with dark phototypes, which provides deeper penetration and reduces the risk of superficial thermal damage and scarring. Additionally, the choice of a large beam spot diameter reduces light scattering and contributes to a greater concentration of energy at the level of pigment granules in the dermis. In the event of a decrease in the efficiency of one laser, it is not recommended to compensate for this by reducing the beam size and increasing the fluence, since such a strategy increases the risk of surface damage; instead, it is advisable to switch to an alternative wavelength [2]. The selection of radiation whose absorption does not coincide with the visible color of the pigment is also crucial, since the color of the tattoo is a spectrum that is reflected, not absorbed, and therefore the laser should operate in a range that provides maximum absorption by the pigment. The combination of these physical and biological principles forms the basis of the selective photothermolytic action of Q-switched lasers and determines their status as optimal systems for safe and effective tattoo removal [4]. At the same time, the performance is affected by the characteristics of the dye (structure, color, depth of occurrence), as well as individual skin properties. Multiple sessions may be required for complete removal, and some patients experience temporary changes in pigmentation or skin texture. The advantages and disadvantages of laser use are summarized in Table 2.

Table 2 – Advantages and limitations of Q-switched lasers

Advantages	**Limitations**
High pigment selectivity	Less effective for light, yellow, and complex organic pigments
Minimal risk of scarring	Temporary pigmentation disturbances may occur
Fast recovery after the procedure	Multiple sessions are required
Cosmetically appealing results	The procedure is painful and requires anesthesia
Safety when proper technique is used	Risk of paradoxical darkening of certain pigment compositions

Note: systematized by the author based on research [7]

Fractional laser systems occupy an important place in aesthetic dermatology as a technology capable of affecting the deep layers of the skin while preserving a part of the intact tissues. This technology provides faster recovery compared to traditional ablative laser resurfacing. Depending on the principle of action, fractional ablative (AFR) and non-ablative fractional (NAFR) lasers demonstrate different efficacy and safety profiles: AFR creates microthermal zones of tissue vaporization and usually provides a more pronounced clinical effect, while NAFR forms deep thermal coagulation mycoses without destroying the epidermis, which minimizes healing reactions. Combined protocols combining both modes are used to increase efficiency in cases of persistent defects or deeply located pigment [10].

Table 3 – Key characteristics of fractional and combined lasers

Parameter	**Ablative fractional lasers (AFR)**	**Non-ablative fractional lasers (NAFR)**
Level of clinical improvement	26–83%	26–50%
Mechanism of action	Removal of microcolumns of tissue (ablation)	Tissue coagulation without epidermal destruction
Erythema duration	3–14 days	1–3 days
Full skin regeneration	Up to 12 weeks	Up to 1 week
Post-inflammatory hyperpigmentation (PIH) frequency	Up to 92.3%	Up to 13%
PIH duration	Up to 6 months	Up to 1 week

Pain level during the procedure	5.9–8.1 points (on a 1–10 scale)	3.9–5.66 points
Clinical advantage	Pronounced correction of deep defects	Better tolerance, fewer side effects
Main limitations	High trauma, prolonged downtime	Less powerful effect for deep skin changes

Note: systematized by the author based on [10]

Non-laser tattoo removal methods have been developed as an alternative to laser technologies or as additional approaches in situations where laser exposure is limited or ineffective. These methods cover a wide range of physical, chemical and surgical interventions aimed at mechanical removal, destruction or removal of pigment through the surface layers of the skin. However, a common feature of all non-laser methods is their low selectivity of action, as they affect not only the dye, but also the surrounding tissues, which leads to an increased risk of damage and cosmetic defects compared to laser removal. The main non-laser methods include: dermabrasion, salabrasion and chemical removal.

Dermabrasion as a method of tattoo removal is based on controlled abrasive damage to the skin by mechanically grinding the epidermis and part of the dermis to the level of pigment. Special grinding burs, diamond or wire brushes are used, which ensure gradual tissue removal under the visual control of the doctor. During the procedure, the pigment is partially removed together with the destroyed layers of the dermis, and partially excreted by activating the local inflammatory reaction and subsequent phagocytic activity of macrophages. Modified approaches, in particular multi-layer stepwise grinding, allow for more precise control of the depth of ablation and minimize the risk of excessive trauma. After completion of dermabrasion, an open wound surface is formed, which requires prolonged repair with the formation of new layers of the epidermis and remodeling of dermal structures. During this period, intense inflammation, the formation of granulation tissue, excessive collagen production are possible, which increases the likelihood of scarring. In addition, post-inflammatory hyper- or hypopigmentation may occur as a result of impaired melanocytic regulation, especially in patients with a darker skin phototype. Thus, despite its potential efficacy, the method requires careful patient selection and strict adherence to technical parameters to reduce the risk of complications [5].

Salabrasion is a mechanical option in which the skin is abraded with table salt. It is considered an economical and technically simple method, but the level of pain, the possibility of infection and the almost guaranteed appearance of scars make it less acceptable, especially for professional dermatological practice. The results are often partial and heterogeneous, and anatomical areas with thin skin are not recommended for this method [5].

Chemical tattoo removal using caustic agents, primarily trichloroacetic acid (TCA) and phenol, is based on the induction of a controlled chemical burn of the skin. TCA, which causes protein coagulation and necrosis of the epidermis and superficial dermis, has historically been used to ablate pigmented areas. Phenol has an even deeper damaging effect, destroying skin cells down to the middle dermis and is able to penetrate into the systemic circulation, which is accompanied by the risk of cardiotoxicity, nephrotoxicity and neurotoxic effects. Both agents demonstrate low selectivity for tattoo pigment, since its particles are localized in the dermis at a considerable depth, which leads to incomplete or uneven removal of the pigment. Due to the uncontrolled depth of the lesion, the high probability of scarring, changes in skin color and texture, the development of secondary infections and a long healing period, methods based on TCA and phenol have been almost completely replaced from modern dermatological practice. An additional factor in the rejection of these technologies is the emergence of laser methods that can provide selective destruction of pigment without massive damage to intact tissues.

Thus, the use of caustic agents for tattoo correction is currently considered an outdated, ineffective, and dangerous intervention that should be limited or completely replaced by modern technologies [5].

Table 4 – Comparative characteristics of non-laser tattoo removal methods

Method	**Advantages**	**Disadvantages**
Dermabrasion	Relatively fast removal of surface pigment; suitable for large tattoos	High trauma; scarring; prolonged healing; risk of infections
Salabrasion	Low-cost and accessible technique; no need for special equipment	Severe pain; uneven results; high risk of scarring and textural defects
Chemical removers (acids)	Potential for rapid pigment lightening; various reagents can be used based on the goal	Burns, necrosis, scarring; risk of oncological complications; significant cosmetic defects

Note: Systematized by the author based on research [5].

The use of non-laser tattoo removal methods is inextricably linked to an increased risk of undesirable consequences. Due to the non-specific effect on all tissues in the intervention area, both acute reactions are possible, including intense pain, bleeding, infectious lesions, and delayed complications - scarring, keloid changes, atrophic defects, pigmentation disorders or persistent erythema. Incomplete removal of pigment remains a characteristic problem of these techniques, which often requires repeated interventions and, accordingly, increases the trauma. Such results do not always meet the aesthetic expectations of patients, and the risks of irreversible damage make non-laser methods of limited use in modern aesthetic medicine [5].

Modern prospects for permanent makeup removal are closely related to the evolution of laser systems - the transition from classic nanosecond Q-switched Nd:YAG to picosecond platforms with different wavelengths. This expands the spectrum of targeted pigments (including “problematic” green, blue and mixed tones) and reduces the risk of post-inflammatory hypo-/hyperpigmentation, which is especially important when working with delicate areas of the facial PM (eyebrows, interciliary, lip contour) [6].

In parallel, negatively light-dependent methods are also developing - surgical, radiofrequency, dermabrasion, sali- and chemodestructive techniques, which in clinical practice are increasingly positioned as an alternative or addition to lasers, in particular in cases of allergic reactions to pigment or contraindications to phototherapy. However, a review by Dash et al. demonstrates that traditional non-laser approaches (dermabrasion, salabrasion, chemical agents) are still associated with a high risk of scarring and dyschromia, which stimulates the search for more selective, tissue-sparing “removers” and combined protocols for cosmetic tattoos and PM [5].

Against this background, strategies that combine laser fragmentation of the pigment with subsequent “purification” using chemical or fractional ablative methods, as well as approaches that take into account the nanoscale structure of pigment particles and optimize the pulse duration and energy density for maximum selective destruction with minimal thermal damage to the dermis [5,6], look promising. The successful implementation of these technologies, especially in the area of permanent makeup, critically depends on the high level of training of the specialist and strict adherence to safety protocols, which is considered in the literature as a key factor in reducing the frequency of complications.

Conclusions. Removal of unsuccessful permanent makeup is currently carried out by two methods: laser and non-laser procedures. Laser technologies, especially Q-switched and picosecond systems, retain the status of the “gold standard” due to their high efficiency and safety. At the same time, non-laser methods have practical significance in cases of insufficient effectiveness of laser exposure or limited availability, although these methods are characterized by more negative consequences or risks of their use.

Further development of tattoo removal should be aimed at improving equipment, creating more atraumatic removers and forming combined therapeutic strategies. Patient safety, rational choice of technique and qualified performance of procedures remain priorities, which is the key to optimal clinical results.

References

1. Ahčan U., Lukac M., Grad L., Gorsic M., Bacak I., Topcic V. q-switched laser tattoo removal. Zdravniški vestnik, 2013, №82, 552–563. URL: https://www.researchgate.net/publication/293555951_Q-switched_laser_tattoo_removal
2. Alster T.S., Lupton J.R. Lasers in dermatology: an overview of types and applications. Dermatologic Clinics, 2001, №19(3), 489–507. URL: https://pubmed.ncbi.nlm.nih.gov/11721648/
3. Bäumler W. Absorption characteristics of pigments used in tattoo and permanent make-up and their impact on laser treatment. Laser Physics, 2010, №20(4), 994–1001. URL: https://www.semanticscholar.org/paper/Absorption%2C-distribution%2C-metabolism-and-excretion-B%C3%A4umler/4657770912f8ff77d03d6a6a20bfe853d0956da0
4. Bernstein E.F. Laser tattoo removal. Seminars in Plastic Surgery, 2007, №21(3), 175–192. URL: https://www.researchgate.net/publication/44692121_Laser_Tattoo_Removal
5. Dash G., Patil A., Kassir M., Goldman M.P., Gold M.H., Adatto M., Große-Büning S., Grabbe S., Goldust M. Non-laser treatment for tattoo removal. Journal of Cosmetic Dermatology, 2023, №22(1), 74–78. DOI: https://doi.org/10.1111/jocd.14819
6. Hohman, M. H., & Ramsey, M. L. Laser tattoo removal. In StatPearls. StatPearls Publishing, 2025. URL: https://www.ncbi.nlm.nih.gov/books/NBK442007/
7. Kilmer S.L., Anderson R.R. Clinical use of the q-switched ruby and the q-switched nd:yag (1064 nm and 532 nm) lasers for treatment of tattoos. Journal of Dermatologic Surgery and Oncology, 1993, №19(4), 330–338. URL: https://pubmed.ncbi.nlm.nih.gov/8478472/
8. Kossida T., Rigopoulos D., Katsambas A., Anderson R.R. Optimal tattoo removal in a single laser session based on the method of repeated exposures. Journal of the American Academy of Dermatology, 2012, №66(2), 271–277. DOI: https://doi.org/10.1016/j.jaad.2011.07.024
9. Mitwalli H., Alfurayh N. Tattoo regret, complications, and removal: a cross-sectional study among tattooed individuals in saudi arabia. Dermatology Research and Practice, 2024, №5673785. DOI: https://doi.org/10.1155/2024/5673785
10. Ong M.W., Bashir S.J. Fractional laser resurfacing for acne scars: a review. British Journal of Dermatology, 2012, №166(6), 1160–1169. DOI: https://doi.org/10.1111/j.1365-2133.2012.10870.x
11. Ross V., Naseef G., Lin G., Kelly M., Michaud N., Flotte T.J., Raythen S., Anderson R.R. Comparison of responses of tattoos to picosecond and nanosecond q-switched neodymium: yag lasers. Archives of Dermatology, 1998, №134(2), 167–171. URL: https://pubmed.ncbi.nlm.nih.gov/9487208/