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BIOLOGICAL PROCESSES OF SKIN REGENERATION AFTER PERMANENT MAKEUP: HEALING PHASES

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Abstract. *The article is devoted to the analysis of biological processes of skin regeneration after permanent makeup with an emphasis on the healing phases. The purpose of the study is to investigate the biological processes of skin regeneration after permanent makeup. To achieve this goal, general scientific methods of cognition are used in the research process: analysis, synthesis, systematization, induction and deduction. The results of the study show that skin healing after permanent makeup occurs in three stages: the first stage is inflammatory, the second is proliferative, the third is remodeling. The results of the study of these stages are characterized by sequential cellular changes, changes in pigmentation and changes in the microbial environment of the skin. The results of the study show that different compositions of dyes and components directly affect the degree of tissue irritation, depth of penetration and color stability. Bacterial activity in the area of microtrauma causes inflammation and slows down the skin healing process, and failure to follow care instructions increases the risk of complications. The study shows that timely skin cleansing, moisture restriction in the early stages and protection from ultraviolet radiation stabilize the pigment and improve the physiological process of epithelialization. The study also presents the author's healing technique depending on the anatomical area of application and identifies cellular mechanisms that allow creating an interdisciplinary basis for further clinical optimization of the micropigmentation procedure. The practical significance of the study lies in the formation of personalized care protocols that can be used by cosmetologists, which ultimately improves the quality and safety of permanent makeup procedures.*

Keywords: *permanent makeup, skin regeneration, pigment, microbiome, post-procedure care.*

Introduction

In recent decades, there has been a growing trend and popularity of permanent makeup tattoos. According to national statistics, 26% of women in Europe regularly use permanent makeup, and the number of these women is growing. The procedure is becoming not so much a specialized cosmetic service as a personal care practice, leading to changes in aesthetic demands and growing confidence in invasive cosmetic techniques. Women are more likely to resort to micropigmentation procedures for eyebrows, lips, and eyelids. This allows for long-lasting correction and saves time on daily makeup. However, at the same time, every woman understands that permanent makeup, although completely affordable, can cause a number of complications. Statistics show that 12% of women experience certain difficulties and complications

after micropigmentation, and the average recovery period is up to 15 days [10]. This necessitates a deeper study of the biological processes that occur in the skin after pigment application, as well as an understanding of the sequence and characteristics of the various healing phases, since the more thorough the care, the fewer the negative reactions and consequences of this cosmetic procedure.

Literature Review

The analysis of scientific works indicates that considerable attention has been paid to the topic of skin regeneration after permanent makeup, covering biological, microbiological and material science aspects. A systematic review by D. Bakova [1] describes in detail the risks associated with a violation of the skin barrier function. The study by G. Bansod [2] focused on the influence of lipophilicity, permeability and chemical composition of pigments on the level of tissue irritation and the depth of their penetration into the dermis. In particular, such results allow us to trace the general dynamics of reactions that occur after invasive cosmetic interventions. In turn, K. Gench [3] emphasizes that properly organized post-procedure care is crucial for the course of the early stages of healing, therefore the author emphasizes the need for care procedures to achieve the desired effect.

First of all, it is worth noting that microbiological factors play a significant role in the development of inflammatory reactions. For example, V. Geng, Y. Zhang and Y. Cao [4] demonstrate the participation of P. acnes in the formation of persistent inflammation after the formation of microdamages. The scientific works are complemented by specialized web resources: elle-permanent.ae [5], caitlynmilkbeauty.com [6], zahra-beauty.com [7], klinikaantiaging.pl [8], minounails.com [9], alenabrowart.com [11]. They contain a detailed description of the healing dynamics, including daily changes in the state of the epidermis after micropigmentation, as well as recommendations for proper care according to the stages of recovery.

The purpose of this article is to investigate the biological processes of skin regeneration after permanent makeup. To achieve this goal, the following tasks will be performed: 1) analyze the nature of skin damage during permanent makeup

application; 2) reveal the sequence and specifics of the main stages of healing; 3) determine the key principles of post-procedure care.

Research Results

Today, tattoos and permanent makeup are becoming particularly popular among women of all ages. Every year, more and more men are turning to this procedure. The geography of the spread of this cosmetic procedure also covers more and more countries around the world. All this contributes to the fact that permanent makeup technology is constantly improving, and materials and tools are becoming more effective.

At the same time, these procedures are not limited to cosmetic intervention, as they involve invasive effects: the integrity of the skin is disrupted, causing local irritation and initiating a series of inflammatory reactions. Research in scientific literature shows that different types of skin reactions occur at different stages of the recovery process after permanent makeup.

In particular, approximately 8.8% of cases occur in the early stages of recovery, accompanied by itching. In addition to itching, swelling is also characteristic, observed in approximately 13% of people who have undergone the procedure. The most common reactions also include redness, which is a typical manifestation [1, 10], increased skin sensitivity in areas where permanent makeup is applied [1, 3, 8], burning and heat sensations caused by active local inflammation or a reaction to the pigment in the first days after the procedure.

Typical manifestations also include the formation of scabs on the skin surface [5], [6], [7], [11], local irritation associated with a reaction to pigments [1, 2], as well as delayed inflammatory reactions, which may be accompanied by redness, itching, and occur not in the early but in the later stages [1].

When it comes to reactions to various chemicals contained in ink, according to source [2], the most influential chemicals that can cause local inflammation include iron oxide, titanium dioxide, cadmium sulfide, chromium oxide, aluminum compounds, nickel, and organic dyes. All of these substances can cause dryness, photosensitivity reactions, the appearance of reactive yellow pigments, green

pigments, discoloration, allergic reactions, hypersensitivity rashes, and other types of allergic reactions. It can be argued that it is not so much the permeability itself as the chemical composition of the substances that enter the skin that causes various reactions.

Depending on the pigments used for the invasion, the nature of the skin reaction changes. Primary irritation mainly manifests itself as itching and hyperemia. However, with prolonged exposure, granulomas or isolated dermatoses may form. It is also likely that the microbial balance will be disturbed, which significantly affects the onset and maintenance of the inflammatory process [4].

Let us summarize the main aspects of this problem in Table 1.

Table 1 – Factors causing skin irritation after permanent makeup

Indicator	Value
Skin barrier disruption	Mechanical trauma, microbiome alteration, dysbiosis
Pigment composition	Metals, organic dyes, PAHs, and other impurities
Physicochemical properties	Log P, Log Kp, TPSA, solubility
Inflammatory responses	Release of IL-1β, IL-6, localized inflammation
Impurity-related risks	Chemical contaminants, low standardization of pigments
Microbiome role	*P. acnes* activity, pH alteration, reduced bacteriostatic control

Source: systematized by the author based on sources [1, 2, 4]

Therefore, it can be noted that skin irritation after permanent makeup is complex in nature and is caused by chemical, physiological, and microbiological factors. Such a multi-level interaction requires increased attention to the safety of the pigment composition and the quality of the procedure.

The healing process after permanent makeup is gradual. It can be divided into several stages [5]. The first 24 hours are the most critical. During this period, the skin must remain dry, as excessive moisture or mechanical stress can affect the uniformity of pigment penetration. First of all, it is necessary to properly cleanse the skin without rubbing, as well as avoid cosmetics, using specially selected care products, which, as a result, creates favorable conditions for regenerative processes and positively affects

the duration and quality of the result [3].

In the days following the procedure, almost all patients experience increased color intensity due to swelling: the pigment becomes brighter, but this is a natural reaction of the cells to the intervention and has no long-term effect. This condition lasts from 3 to 7 days and is a sign of the beginning of the first regenerative processes [6].

After this stage, it is very important to take proper care of the skin, in particular, do not pick at scabs or excessively moisturize the skin, as this can lead to a violation of pigment distribution. Adherence to hygiene rules and limiting external irritants can reduce the healing time to the physiological norm, which is usually up to 2 weeks [9].

Thus, adherence to certain restrictions on visiting swimming pools, saunas, and exposure to ultraviolet light allows the pigment to remain stable. In addition, it is important to monitor water balance and nutrition, which is especially important for permanent lip makeup, as this area of the body is most damaged and traumatized during eating among all regenerating tissues [8].

Considering the early stages of regeneration, it is worth noting that the process of epithelialization requires not only balanced care, but also limited exposure to irritants. In particular, it is necessary to use the correct neutral solutions and refrain from using decorative cosmetics, as the skin is particularly permeable during this period, and the ingress of foreign substances into microtraumas obtained during permanent makeup can contribute to irritation or even inflammatory reactions [10].

After the first week, the pigment gradually becomes less bright, and its shade becomes more subdued. During permanent makeup, it is important to consider the uniform perception of color or its excessive lightening – during this period, the color of permanent makeup returns to a soft, stable shade and gains its saturation over the next week [7].

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Considering the early stages of regeneration, it is worth noting that the recovery process requires not only balanced care, but also limited access to irritants. First of all, it is about using the right neutral solutions. It is also necessary to abandon decorative cosmetics, since the skin has a particularly high permeability, and the ingress of foreign substances into microtraumas obtained during permanent makeup can contribute to the occurrence of irritations and even inflammatory reactions [11].

After the end of the first week, the pigment gradually reduces its brightness, and its shade becomes more restrained. After permanent makeup, you should not immediately expect a uniform perception of color, it may be more lightened, since all reactions in the body occur over several weeks, and the expected effect of uniformity appears over time [7].

Table 2 – Stages of skin recovery after PMU

Stage	Process Characteristics	Significance for Outcome
First 0–24 hours	High skin vulnerability, initial pigment fixation	Prevention of infection, proper pigment anchoring
1–2 weeks	Active healing, scab formation, pigment stabilization	Ensures even pigmentation, reduces risk of complications
After 3 weeks onward	Completion of healing, long-term stabilization of the result	Prolongs pigment retention, preserves aesthetic quality

The author of this study has extensive experience in permanent makeup, and therefore has developed a proprietary healing procedure that involves the implementation of a proprietary approach that ensures greater predictability and controllability of permanent makeup results, taking into account the specific mechanisms of skin regeneration and micropigmentation.

The author notes that in the medium-term skin recovery period, which lasts from 4 to 6 weeks, protection from ultraviolet radiation is important, since at this stage the pigment needs to stabilize. In particular, regular use of sunscreen prevents photodegradation of pigment particles, and limiting the use of exfoliants and active cosmetic ingredients preserves the color saturation of the makeup.

The author also emphasizes that excessive stimulation of the skin can lead to accelerated displacement of pigment from the upper layers of the epidermis, therefore, scratching, massage and pressure in the areas of invasion are not recommended. At the final stage of recovery, it is important to assess the need for additional correction, which is associated with the individual characteristics of the skin and its reaction to the procedure, in some cases the procedure must be partially repeated [3], due to the fact that the pigment lightens over time. However, timely correction allows you to restore symmetry and optimize the result, and the final tone is formed only after the completion of all regenerative processes. Let's summarize the main aspects of skin recovery after permanent makeup in Table 3.

Therefore, complete skin recovery after permanent makeup is based on a clear sequence of actions, and their adherence affects the quality and durability of makeup, as well as the post-invasive recovery period.

Table 3 – Stages of skin recovery after permanent makeup and skin care products

What to Do	Stage	Care Products and Measures
Keep the area dry, blot lymphatic fluid	Acute inflammatory phase (Day 1)	Sterile tissues, recommended non-rubbing cleansing solution
Avoid touching, do not wet the area	Oxidation and intense darkening (Days 2–3)	No topical products, maintain dry conditions
Do not pick scabs, follow gentle cleansing routines	Desquamation and peeling (Days 4–7)	Mild sulfate-free cleanser, minimal moisturizing as advised
Allow the skin to regenerate naturally	"Ghosting" phase (Days 8–14)	No active cosmetics, neutral cleansing only
Protect the area from UV, avoid active ingredients	Color stabilization (Days 15–30)	SPF 30+, neutral cream free of acids and retinoids
Prepare for touch-up, maintain general skin hygiene	Full recovery (>30 days)	Sunscreens, basic non-irritating skincare

Conclusions

The skin's reaction to permanent makeup largely depends on the depth of needle penetration. The presence and composition of pigment dyes also affect this. The individual reactions of the body to them are no less important. Because of this, the manifestations of permanent makeup can vary from normal physiological to severe allergic. Such reactions may include itching, redness, local swelling. Increased sensitivity or the formation of crusts is also observed. With excessive reactivity, granulomas, contact dermatitis or toxicological changes may occur. The composition of the pigment and its properties determine the intensity and duration of such manifestations.

The healing process occurs in several stages. Initial stage: it is important to respond correctly to minor inflammatory processes, because proper care contributes to rapid healing and the effective manifestation of the desired color. Middle stage: the renewal process is activated, peeling appears, after which the pigment gradually penetrates the tissues. In the long-term phase, the skin structure stabilizes, and the pigment acquires its final shade. Each phase has its own characteristics and requires appropriate care.

In the initial phase, it is important to keep the skin dry and avoid mechanical

friction or irritation. In the middle phase, it is important not to peel off the crusts and limit the use of cosmetics or aggressive products. In the long-term phase, it is important to protect the skin from the sun, avoid scrubs and provide delicate care, which allows the pigment to finally settle. A long-term and comprehensive approach helps to maintain an even color and ensure the effectiveness of the cosmetic procedure.

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