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Innovative Methods Of Miscellaneous Skin Inclusions Removal And Post-Inflammatory Hyperpigmentation Correction

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Abstract: Scarless tattoo extraction remains as a major problem in a cosmetology field nowadays. At the moment laser removing method is a basic procedure for tattoo removal. However, this technology is painful and leads to significant trauma of the skin cover. Thise article presents a new combination of laser and chemical technique for skin inclusions removal. The group of techniques belongs to the chemical industry and represents a lightning and neutralizing composition and a method for removing a dye introduced under the skin. The skin area with dye is exposed to a laser effect. After laser exposure an oxidizing composition of 2-3 mm thickness is applied. Oxidizing composition: carboxylic acids, fermented celandine oil extracts and propylene-glycol celandine extracts. The main novelty of the method is presented by several chain processes: in applying of the oxidizing composition on the skin surface after laser radiation, a significant role is played by physicochemical characteristics changes of the skin. Without the skin surface damaging, the percentage of chemical reactions dissociations aimed at removing the pigment is raising which shows better efficiency comparing with classical laser method of dye particles removing.

Keywords: tattoos, laser, oxidizing, hyperpigmentation, dye removal

1. INTRODUCTION

Despite significant advances in cosmetic surgery, scar less tattoo removing as well as post inflammatory hyperpigmentation (PIH) correction remains as the leading problems of modern cosmetology [1]. The chemical composition and features of extracted agents is quite different: coal (carbon), bitumen, gunpowder, mechanical dirt, graphite particles. Most frequent foreign pigment removal happens as a result of unsuccessful cosmetic procedures, cosmetic tattooing, under specific working conditions (such as the coal industry, varnish industry, metallurgy), occupations associated with increased danger (emergency situations), as well as creative professions associated with a certain risk (stuntman). Foreign body extraction is the elimination of dye large particles, as well as particles of potentially coloring substances that enter the skin when injured (coal, ground) [2]. Carbon fractions have the highest inertness and are difficult to extract from the skin [3].

Tattoos removal growth. Procedure of intradermal multicolor pigment granules insertion is called tattooing [4]. Also, tattoo formation can be the result of accidents and trauma. Tattoos can broadly be divided into professional, amateur, cosmetic, traumatic, or medical tattoos. Professional tattoos are applied with a tattoo machine into the deeper layer of the dermis, and are applied to be permanent in nature [5]. The worldwide tattoo prevalence is 10-20% depending on the region, population of the country and the time of survey

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performing [6]. Unfortunately, there are still no strict and common legislation for the tattoo safety regulation, therefore quantity of tattoos complication is tending to grew up [7].

Due to the rising popularity of tattoos, demand for their removal has also increased [8]. Unfortunately, the removal of tattoos is generally costlier and time consuming than acquiring them [5]. Motivation for tattoo removal includes new jobs or careers, the need to portray a certain image at work or in new social circles, and new, negative feelings towards old tattoos [9]. Some patients with tattoo reactions have reduced quality of life and suffer from itch [10].

"Coal Tattooing". Despite the fact deep coal mines are closing, there are still negative effects of mining on physical health that need to be addressed. Mining exposes workers to a variety of potentially harmful agents, including fuels, reagents, solvents, detergents, chemicals, coal dust, silica dust, diesel particulate matter, asbestos, welding fumes, poisonous plants and metal dust. These may be inhaled, ingested or absorbed through the skin, eyes, mucous membranes or ears. Miners are often exposed to them for decades before any adverse effects are noticed. In the past, they may not always have been adequately instructed about the health risks involved and the safety precautions required [11].

Coal tattooing, also known as 'colliers' stripes' is resulted from scratches and small injuries that healed without scarring, in which coal dust was deposited before healing was complete. Commonly found on the face, forearms and hands, they presented as light greyish-blue linear or angular markings, measuring up to 1 inch in length [12-13].

Chronic (cumulative) irritant contact dermatitis used to be commonly seen in miners. Coal dust is presented in miners working process, therefore unprotected by work-wear human skin resorb some portion of the dust. Coal, is a black dye, freely moves in the air and through the sweat glands enters the various layers of the dermis reaching the lymph nodes, with further fibrous tissue overgrow and cosmetic defect causing. The work conditions, the mine's geographical location, depth, temperature, humidity and ventilation, and the physical and chemical properties of the extracted mineral can all have a role in its aetiology [14-15].

Post inflammatory hyperpigmentation (PIH). Post inflammatory hyperpigmentation (PIH), also known as post inflammatory melanosis, is a reactive hypermelanosis of the skin that occurs as a sequela of cutaneous inflammation. Common causes of PIH include acne vulgaris, eczematous dermatoses, and burn injury. PIH is a frustrating problem that can have a strong psychologic toll on affected patients. The provoking inflammatory process that leads to post inflammatory hyperpigmentation (PIH) can be endogenous or exogenous. Common endogenous causes of PIH include acne vulgaris, atopic dermatitis, irritant contact dermatitis, allergic contact dermatitis, psoriasis, and lichen planus. Accidental burns, nonionizing radiation therapy, phototoxicity, chemical peels, and laser procedures are examples of exogenous causes [16-17].

Abnormal hyperpigmentation. Post-inflammatory hyperpigmentation is one of the most common and rather persistent in dark-skinned people. The different skin conditions like inflammatory dermatoses, trauma and medical interventions (such as laser therapy) are in dark people often the etiology of remaining hyperpigmentation. Sunlight, some medication and chemicals often worsen the spots. The dyschromia follows the pattern and distribution of the original dermatoses, but its intensity is not necessarily related to the degree of previous inflammation. Epidermal pigmentation is mostly brown and fades out in several months. Dermal pigmentation has a grey-brown color and is generally permanent for years.3 Treatment of post-inflammatory hyperpigmentation is difficult. The primary goal of therapy is treating the etiology. Most significant clinical improvement for the lesions is directly correlated with different topical therapies such as depigmenting agents. Particularly important is the combination of these therapies with the frequented use of sunscreens [18].

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Skin inclusions elimination approaches. Through the years, many different methods of tattoo removal have been explored. Older techniques involve removal of the outer skin layers using mechanical (dermabrasion and salabrasion), chemical, or thermal (cryosurgery and cauterization) methods. Progress in laser technology offers alternative treatments to patients with cutaneous discolorations, including post inflammatory hyperpigmentation and tattoos [19-20].

Lasers have revolutionized the way tattoos are treated and have become the gold standard of treatment. To achieve optimal cosmetic outcome of treatment, lasers emitting high energies and short pulses are required to adequately destroy tattoo ink [21]. Lasers based on the principle of selective photothermolysis are now being used to remove black as well as colorful tattoos with varying successes [22].

Among modern methods of ink removal are chemical subcutaneous, chemical external, laser [23]. Currently, the only FDA approved tattoo removal devices are laser based; FDA has not approved the topical or injectables for tattoo removal [24].

We are presenting a new combination of laser and chemical technique for skin inclusions removal.

2. MATERIAL AND METHODS

Application of a lightening agent after laser radiation exposure on the target area (A variant). Pigment particles in the skin are unevenly located, with different depths (vary from the epidermis border and the dermis, to presence in the lymph nodes and subcutaneous fat). These particles also have an uneven spot shaped (dashed) dot-like deposition, various concentrations and relation to the skin relief (hypotrophic, hypertrophic type), different fraction, density, and other physicochemical characteristics [25-26]. The skin area with dye is exposed to a laser effect equal to one impulse of the untreated skin zone. For this technique we use different types of lasers: Nd-YAG, QSwitched, Picosecond, Alexandrite, Erbium. The power for each laser modification should be minimal, without increasing at further stages of removal. The nozzle of the laser has be 532 nm, 1064 nm, depending on the source. After laser exposure an oxidizing composition of 2-3 mm thickness is applied, the exposure time is 1 minute. Oxidizing composition: carboxylic acids, fermented celandine oil extracts and propylene-glycol celandine extracts (Table 1). The maximum processing area should not exceed 23 cm2. After 2-3 minutes, the area is wiped with a dry disk; the zone is cooled according to the laser modification algorithm.

Table 1. Oxidizing composition components

A composition component	Ingredient	Initial concentration of the ingredient active substance	The part of the substance in the finished product, %	Active substance content in the finished product, %	pH
Oxidizing agent	Glycolic acid	32.2 % water solution	15-20	4.9-5.9	3.6
Oxidizing agent	Lactic acid	28.9 % water solution	15-20	3.1-4.1	3.6
Entering agent	Propylene glycol	15.0 % water solution	30-40	14.0	3.6
Lightening agent	Celandine extract	99.5 %	30-40	24.8-26.8	3.6
Viscosity	Glycerin	99.5 %	2-5	0.5-2.2	3.6

stabilizing agent					
Solvent	Water	100 %	12-14	78.5-79.2	3.6

The lightening area is neutralized by a composition containing triethanolamine or diethanolamine. A sterile dressing is applied then, and the regeneration process begins [28].

After the subject area is occurred by laser, a laser's acoustic wave produces photomechanical fragmentation of the particle is formed. Herewith the particles of the extracting pigment are decaying into small fractions over the extracted dye area, remaining directly in the skin layers. The tissue at this moment remains visually intact, but its physical and chemical condition changes. The temperature increasing leads to the hydrogen bonds rupturing and raising of capillary pressure and microcirculation. The molecules structure of the irradiated tissue is disturbed.

The rate of chemical and biological processes of such tissue increases with the oxidizing agent participation deposited after laser exposure to the lightning area. Pigment particles presented by oxides, organic and inorganic compounds, enter into various types of reactions with an oxidizing composition. Oxidizing composition applying reduces the time of dye particles complete removal and minimize the risk of color inversion.

The main novelty of our method is presented by several chain processes: in applying of the oxidizing composition on the skin surface after laser radiation, a significant role is played by physicochemical characteristics changes of the skin. Without the skin surface damaging, the percentage of chemical reactions dissociations aimed at removing the pigment is raising which shows better efficiency comparing with classical laser method of dye particles removing. The various characteristics of foreign intradermal particles are not fundamental, which is a significant advantage of the combined method.

Application of a lightening agent before laser radiation exposure on the target area (B variant). A thin layer of the oxidizing composition is applied on the treated skin for 1 minute, and then the skin is exposed to laser radiation. The skin area is cooled according to the algorithm established by the laser removal procedure, the area is neutralized, a sterile dressing is applied, and then the regeneration process takes place.

The high lightning effect of the oxidizing agent is ensured by penetrating into the tissue in non-invasive way without skin integrity violation by the laser radiation. The lightning composition enters the upper dermal layers using an amplified laser pulse and enters various skin chemical reactions simultaneously with acoustic effects of laser. Under the laser radiation influence, the oxidizing moisture of the upper dermal skin layer evaporates. Thus the lightning agent resorption percentage at the pigment location level is raising. Due to these mechanisms, dye removal is greatly enhanced. Variant B requires minimal power of lasers.

Advantages of B variant. Despite the fact some lasers enters deep skin layers up to 10 mm, our method ensures increasing tissue absorption coefficient of the radiation, allowing the skin tissues avoiding laser beam damaging. Consequently, pathological processes of excessive skin damage are reducing.

3. RESULTS AND DISCUSSION

The chemical and laser combined method of intradermic particles removal allows to work at minimum laser power, achieving better results without the skin integrity violation, avoiding burn-form skin complications and overheating of large skin areas, due to the enlarged time of intradermic dye processing. The level of laser operation control is reduced, the output result is increased, regardless of the dye type dye and color introduced, and the risk of color gamut inversion is reduced. On the large processing areas while combined method

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using, the risk of general overheating and scar formation is reduced. The risk of skin damage is reduced by decreasing the time of temperature exposure and the absence of the necessity for increasing laser power. The better result of combined method using is also observed in areas with high dye concretion, in "expanded" areas that are considered the most dangerous. It becomes possible to study color tattoos with a single nozzle, absorbing more quantity of his dye, without losing the result. For example, a nozzle with a 1064 nm wavelength without using a nozzle 532 nm, or vice versa 532 nm nozzle, without using 1064 nm. The technology can be applied for mixed tattoos, which could have simultaneously black, red, green, blue, yellow, and other (Fig. 1).

Figure 1. Tattoo removal procedure with combination of chemical and laser methods

During the subcutaneous chemical method, the upper epidermis layer undergoes mechanical destruction to ensure maximum resorption of the active substance by tissues containing the previously introduced dye. The disadvantage of the chemical method is the skin integrity destruction, the inability to predict the exact timing of rehabilitation, excessive injuries, and absence of special tables to establish approximate dates of skin regeneration. External chemical method of intradermic skin particles extraction provides high concentrations of acids and alkalis applying, which can destroy the deeper layers of the skin. The disadvantage of this method is the high percentage of chemical burns, a large rehabilitation period, and uncontrolled destruction of the dermis and epidermis layers arising from the aggressive effects of reagents on the skin. As a result, various pathological tissue changes leading to various types of life disorders. The laser method does not destroy the skin when used correctly, but the risk is increased with an unprofessional approach. For the classical method of operation, combinations of nozzles with various wave parameters are recommended. Another difficulties arising from the danger of re-applying the beam and removing the “colors of risk” - beige, white, light, blue, all colors with an admixture of titanium dioxide. There is also a risk of over large tissue areas overheating, the risk of burns, the risk of color inversion, limitation of work on the skin with increased production of melanin [28-31].

Complications of Laser Tattoo Removal. Laser removal method complications divided into immediate (pain, blistering, urticarial reaction) and delayed (pigmentary changes, paradoxical darkening, allergic reactions, surface changes). The most common complication

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is pigmentary changes, either hypopigmentation or hyperpigmentation. These occur 4-6 weeks after laser treatment and most of them are transient [32] (Fig. 2).

Figure 2. Example of hyperpigmentation correction with chemical and laser methods usage.

4. CONCLUSION

We discovered an optimal method to treat scars after tattooing and hyperpigmentation correction was, which can be used to remove permanent makeup (tattoo) or tattoos. The benefit of the introduction of these techniques is the reduction in the time required to remove the dye, the reduction of skin trauma, the reduction of pain, and the increase in the healing rate of the treated area.

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