

## Core Messages

- ▶ Although *cosmetic tattooing* is a common and popular procedure and usually well-tolerated, complications can occur, including infections and allergic reactions. One of the problems lies in the lack of uniform legislation worldwide, and the lack of control of the production of the substances used.
- ▶ In Permanent Make-Up (PMU), the most common *complications* and patient *dissatisfaction* result from misapplication of the pigment, pigment migration, and pigment fanning. In these cases, the best cosmetic results can be achieved by using lasers, but even these techniques have their pitfalls.
- ▶ *Dermatography* is a modified tattooing technique used to camouflage pathologic skin conditions for scar correction, and as an adjunct to reconstructive surgery. It can also be used for the implantation of pharmacological substances in specific therapeutic indications.
- ▶ Correct information about the risks and a procedure performed by a well-trained professional can minimize complications and dissatisfaction. This applies to the procedure of tattooing as well as to all tattoo-removal techniques.
- ▶ Tattoos can be used for medical indications, more in particular, for field marking in radiation oncology and endoscopy

## 5.1 Introduction

Tattoos are a form of body art that has been practiced throughout history by various culture. Facial cosmetic tattoos date back to ancient Egypt [1, 2]. The introduction of eyelid tattooing in 1984 [3] was the start of cosmetic tattoos. In the last decades, blepharopigmentation, eyebrow tattoos, and lip-lining simulating make-up have become very popular. There are historic arguments that in ancient times tattooing was also performed for medical purposes. The small parallel tattoo lines located over the lumbar spine and the articulations of the lower legs in the well-preserved “man of Hauslabjoch” correlate with radiographic confirmed osteoarthritis of these joints, and could be related to a prehistoric form of acupuncture [4]. Since the nineteenth century, several reports illustrate the medical applications of tattooing for camouflage of vascular birthmarks [5] and scars in ocular [6–8] and reconstructive surgery [9]. Endoscopic tattooing in gastroenterological procedures [10, 11] and “black dot” tattooing to demarcate the field and patient positioning in radiation oncology are common medical practices [12, 13]. Intralesional application of drugs using a tattoo technique has been described for the treatment of viral warts and hypertrophic scars [9].

## 5.2 Technique and Materials

### 5.2.1 Technique

The technique of cosmetic tattooing, also called *micropigmentation*, basically consists of placement of tiny droplets of tattoo ink into the superficial layer of

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the dermis using a traditional tattoo device or a smaller tattoo pen with an oscillating, preferentially disposable, needle. A variety of devices is available depending on the indications and applications. [14] The procedure is very popular nowadays because it is mainly done for cosmetic purposes; it is mostly performed by an experienced beautician with advanced training. While the education of a traditional tattooist is usually provided by established practitioners and learned through practice, cosmetic tattooing is rather an extension to the basic education of a beautician, who is aware of the requirements of appropriate hygiene and good knowledge of the anatomy of the face. The level of implantation of the pigment in cosmetic tattooing is located at the epidermal–dermal junction or in the dermal pars papillare and much more superficial than in conventional permanent decorative tattoos, where the pigment can be found in the mid-dermis. The more superficial application of the pigment will result in the gradual elimination and a spontaneous fading of PMU within a few years in contrast to the permanent character of dermal tattoos. Before starting the procedure, the area is cleaned and disinfected. The performer wears clean gloves during the procedure. (Fig. 5.1) The application of a local anesthetic cream can make the procedure less uncomfortable. For after care, Vaseline or an antibiotic ointment is mostly used. To prevent contamination, preferentially single-use ink caps are advised, and registration of the colors used can be helpful for later corrections and identification in case of an allergic reaction.



**Fig. 5.1** Technique of PMU

The technique of *dermatography*, a variant of micropigmentation, was introduced in 1984 by van der Velden based on the classic Japanese tattooing techniques [9] and performed by means of a modified tattooing device (a van der Velden Derma injector), consisting of an electromagnetic motor driving a needle holder up and down in a stainless-steel tube. On the needle holder, a bundle of needles is attached; the number and arrangement of the needles, as well as the speed and angle of penetration of the skin is adapted depending on the specific application. The technique requires special training, and the procedure needs several sessions usually with one-month interval. A large variety of standard colors can be used and mixed until complete matching of the surrounding skin color is obtained. When the colors are applied in an open pattern, the natural tanning process is preserved. In this application, the natural translucence of the underlying skin is also partially preserved and enhances the natural result. When required, a complete covering of the underlying skin can also be obtained. Immediately after the procedure of tattooing, usually a thin layer of Vaseline is applied on the treated area. Elimination of pigment can occur in the first days of healing. After a healing phase of 2–3 weeks, the remaining pigment particles are stably stored in the dermal macrophages and fibroblasts. A natural fading of about 10% must be expected over the next few years.

### 5.2.2 Materials (See Chap. 2)

In the procedure of tattooing in general, the nature of the material used and the level of implantation influence the quality and stability of the result. *Pigments* are insoluble in water and most organic solvents. *Dyes* in contrast are soluble in water and solvents. In principle, pigments reside permanently and unchanged in the skin, whereas dyes more frequently used in PMU fade. Colors and shades are custom-blended to match the clients' favorite make-up. (Fig. 5.2) The inks used in tattoos and PMU, and the pigments and dyes used in these inks are classified as cosmetics and color additives, which are inert materials. These materials are subject to FDA regulation; however, the FDA does not control the actual practice of tattooing nor the tattoo inks, and many of the ingredients used are not approved for skin contact. A large range of products can easily be bought on the Internet. In Europe, an attempt has



**Fig. 5.2** Materials used in Dermatology

been made by the Council of Europe to regulate the materials according to the standard requirements for food and cosmetics with a recent extension of Resolution ResAP(2008)1 on requirements and criteria for the safety of tattoos and PMU (superseding Resolution ResAP(2003)2 [15]. However, in general, still many materials used for tattooing are not approved for injection or implantation into the skin. Nevertheless, most of the performers do not know the composition of the inks they use, and many individuals unaware of this fact choose to undergo tattooing in its various forms. In dermatography, as proposed by van der Velden, the color pigments are obtained from pharmaceutical suppliers and contain ferri- and ferro-oxide, ferrohydroxide, titaniumdioxide, tartrazine, and carbon. The inks are prepared with alcohol and distilled water to create a set of standard colors with different intensity and can be mixed to obtain a sliding color spectrum. [9] For *medical* purposes, mostly India ink is used. To assure accurate and reproducible positioning of the patient for oncological irradiation, the skin is marked with a set of “black dots” using a sterile needle dipped in India ink [12, 13]. Endoscopic tattooing is a common technique to mark lesions before surgery and enables subsequent endoscopic follow-up. India ink or a sterile suspension of very fine carbon particles [10] can be used. Drugs can be introduced intralesionally with high precision and exact dosage using a dermatography device as described by van der Velden for the treatment of viral warts with bleomycin and hypertrophic scars with triamcinolon [9, 16, 17]. For tattoo removal, pentamonalloylglucose is applied with a separate dermatography technique [18].

### 5.3 Indications

Advertisements use the advantages of PMU, such as being “waterproof,” make-up that does not smear during sporting and swimming, timesaving “wake up with make-up,” always fresh and permanent. Some people choose this procedure because they have physical problems, such as visual impairment or arthrosis of the hands, the neck, and shoulders, to apply regular, temporary make-up. Eyeliner or blepharopigmentation, lip liner and eyebrow coloring are very popular and nowadays well accepted in all social classes.

When applied by an experienced technician, PMU can be more natural and realistic in appearance than conventional make-up. The PMU also offers a solution in patients with allergies to conventional cosmetics. Corneal reconstruction was introduced in ophthalmologic surgery. [6–8, 14] For others, cosmetic tattooing and dermatography are an adjunct to and considered as the finishing touch of reconstructive surgery. [9] Nipple-areola complex (NAC) reconstruction is common after breast reduction or breast-cancer surgery [19, 20]. (Figs. 5.3 and 5.4) This technique can also be used to camouflage traumatic scars, vascular birthmarks, vitiligo, and alopecia. Dermatography has been successfully used over more than 20 years by now for correcting a large spectrum of skin deformities, discolorations and pigmentary changes, and for scar corrections. It is a valuable adjunctive tool in plastic, cosmetic, and maxillofacial surgery. Other therapeutic indications, using pharmacological substances are recalcitrant viral warts, hypertrophic scars, and tattoo



**Fig. 5.3** Technique of Dermatology



**Fig. 5.4** Nipple reconstruction after surgery. Spontaneous fading can be expected within the next months



**Fig. 5.5** Minimal bleeding during the procedure

**Table 5.1** Indications for cosmetic and medical tattoos

Cosmetic indications	Medical indications
<i>Alternative for conventional make-up</i>	<i>Camouflage for</i>
Eye liner	Scars (accidental and surgical)
Lip liner	Nipple reconstruction (NAC)
Eyebrows	Birthmarks
	Alopecia/vitiligo
<i>Everyone but in particular</i>	<i>Other medical indications</i>
Patients with allergy for conventional make-up	Tattoo removal
Disabled persons (arthrosis)	Endoscopy
Vision impairment	Corneal reconstruction (ophthalmology)
Hay fever	Radiation oncology
Contact lenses	Chemotherapy of viral warts
	Hypertrophic scars

removal. [9, 16, 17, 18] Medical applications of tattooing include field demarcation for radiation oncology and endoscopy [10–13]. Tattoos in general may play an important role in forensic medicine, and they can simplify identification [21] (Table 5.1).

## 5.4 Risks and Complications

(See also Chaps. 2 and 6)

### 5.4.1 Short-Term Complications

The procedure can be quite uncomfortable in sensitive areas such as the lips and eyelids. Less *pain* and little or no *bleeding* occurs when the procedure is performed

by an experienced practitioner (Fig. 5.5). *Swelling and crusting* can be present for a few days, so it is often a “Friday procedure.”

### 5.4.2 Infection

Bacterial *infection* is rare when the procedure is performed in correct hygienic conditions. The advice for the use of a local antiseptic or antibiotic for a few days after the procedure is quite common. However, unsterile equipment and needles can transmit all types of infections, including herpes simplex and blood-borne diseases such as hepatitis and HIV. Even if needles are sterilized or disposable, the electric part of the tattoo pen is not designed to be sterilized. A sterile plastic cover bag is used by many practitioners.

### 5.4.3 Long-Term Complications

The pigments and dyes used in PMU inks are relatively inert and usually well tolerated. *Allergic reactions* are rare; when they occur, they may be particularly troublesome because the pigments can be hard to remove (see Chap. 6). Especially red inks, containing mercury, can cause lichenoid reactions [22, 23]. Fortunately, heavy metals are no longer used in tattoo inks nowadays. Contact dermatitis to other ingredients and additives or to the materials used during and after the procedure such as topical antibiotics can occur. Granulomatous

allergic reactions [24], sunlight-induced reactions [25], foreign body epitheloid granulomas [26], pseudoepitheliomatous hyperplasia [27], and sarcoidosis [28] have been reported.

#### 5.4.4 Other Complications

In general, the procedure causes little discomfort and complications are rare, although adverse events such as eyelid necrosis, loss of eyelashes and secondary cicatricial ectropion, hypertrophic scars and keloids have been reported. To reduce the risk of ocular injury, protective eye shields can be used during the procedure [29]. The risk of herpes simplex reactivation and Koebner effect in patients with a preexisting skin disease such as psoriasis must be considered. Swelling or burning experienced in the affected areas has been reported in people with tattoos and PMU, when undergoing Magnetic Resonance Imaging (MRI). It appears only rarely and without lasting effect [30, 31] in a low-field strength procedure. In high-field strength (>2 T) MRI scan, a crackling sound was reported by Ratnapalan [30], when a tattooed arm entered the magnetic field. The pigment may also interfere with the quality of the image, in particular, in the eye area. This side effect is not a contraindication for the procedure. An informed radiologist can take the appropriate measures to ensure the best results [32].

The most common complications and patient *dissatisfaction* results from misapplication of the pigment, pigment migration, and pigment fanning. (Figs. 5.6–5.9)[33] In this situation, the advantage of being



**Fig. 5.6** Misapplication of PMU ink



**Fig. 5.7** Fanning of the pigment (eye)



**Fig. 5.8** Unhappy about the shape of the lip liner



**Fig. 5.9** Irregular distribution of the pigment

permanent is probably the greatest disadvantage. Whatever their reason for deciding to get PMU, clients should be informed about the risks of the procedure and the side effects that can occur. The major risk for complications is having the procedure performed by an inexperienced person (Table 5.2).

**Table 5.2** Complications

<i>Immediate reactions</i>	
Bleeding (minutes – 1 h)	
Crusting (2–3 days)	
Swelling (2–5 days)	
<i>Infections</i>	<i>Other reactions</i>
Localized	Hypertrophic scars / keloids
Bacterial	Sarcoidosis
Viral (herpes simplex)	Loss of eyelashes
Systemic (blood-borne diseases)	Eyelid necrosis
Hepatitis	Ectropion
HIV	MRI complications
<i>Allergic reactions</i>	<i>Dissatisfaction</i>
Allergic contact dermatitis	Unnatural aspect
Lichenoid reaction	Color
Granuloma	Shape
	Fading
	Fanning
	Distorsion

tones, which seldom gives satisfactory cosmetic results because skin-toned pigments tend to look unnatural because they lack the skins' natural translucence; moreover, dark underlying colors are difficult to hide. (Fig. 5.10) Tretinoin has been used in the removal of eyeliner tattoo.[34]. Nonspecific removal techniques such as surgery and dermabrasion are available, but have a high incidence of scarring, textural, and pigmentary changes. Dermatography with penta-monogalloylglucose has been used for tattoo removal by van der Velden [18]. The best cosmetic results can be achieved by using Q-switched pigment lasers, but even this technique has its pitfalls. Dark, black-based colors fade quite easily after laser treatment. Flesh tones and red tattoos, however, containing titanium dioxide and ferric oxide may show immediate darkening when treated with short-pulse lasers. This is probably caused by an oxidation–reduction reaction. Red–brown colored ferric oxide ( $\text{Fe}_2\text{O}_3$ ) changes into black colored ferrous oxide ( $\text{FeO}$ )

## 5.5 Treatment of Complications

(See Chap. 7)

Medical complications are rare and specific case-related measures can be taken. Localized bacterial infection requires antiseptic or antibiotic treatment to avoid scarring. Allergic manifestations can be treated with topical, intralesional, or systemic corticosteroids [24]. Medical advice is sought mostly because of dissatisfaction by people who want their tattoos to be removed. Objectionable tattoos can be camouflaged with conventional make-up and concealers. With time, most cosmetic tattoos fade spontaneously. Some people attempt to cover unwanted tattoos with a new one with flesh



**Fig. 5.11** Dissatisfaction about the color and shape of the eye-brow PMU



**Fig. 5.10** Unnatural aspect of skin-tone tattoo camouflage



**Fig. 5.12** After treatment with Nd-Yag 532 laser



**Fig. 5.13** Darkening after treatment with Nd-Yag 532 laser



**Fig. 5.14** Final result with complete clearing after treatment with Nd-Yag 1064 laser

[35–38] (Figs. 5.11–5.14). In our experience, when this paradoxical darkening occurs, the dark color can in most cases be removed by consequently using another appropriate wavelength [35, 37, 39]. However, because the result is unpredictable, we advise performing a test in a small area before treating the complete tattoo. Pulsed CO<sub>2</sub> laser has been used successfully in the treatment of lip-liner tattoo [40]. In a case of refractory lip-liner darkening after Q-switched laser treatment [39], treatment with CO<sub>2</sub>-laser also offered a solution.

## 5.6 Conclusions

Although cosmetic tattooing is a common and popular procedure and is usually well tolerated, complications can occur. One of the problems lies in the lack of uniform legislation worldwide and the lack of control of

the production of the substances used. Correct information about the risks and a procedure performed by a well-trained professional can minimize complications and dissatisfaction.

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