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Single Case

Successful Removal of 17 Tattoos Self-Administered Using Black Eyeliner Ink with Quality-Switched Neodymium-Doped Yttrium Aluminum Garnet 1,064-nm Laser: A Case Report

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Abstract
Introduction: Tattooing has a rich historical presence in various human civilizations, with the earliest physical evidence dating back to around 3258 BC. While acceptance of tattoos is increasing in the Western world, negative associations remain. Short-pulsed lasers, such as Q-Switched (QS) or picosecond lasers, are the gold standard for tattoo removal. ***Case Presentation:*** This case report discusses the successful removal of 17 amateur tattoos, which were self-administered by a 19-year-old female patient using black eyeliner ink and sewing needles. The tattoos, distributed across her body, including the face and hands, were partially or completely removed over 10 sessions using the QS Neodymium-doped Yttrium Aluminum Garnet 1,064-nm laser. ***Conclusion:*** The factors that influence the efficacy of tattoo removal are highlighted, including tattoo type, location, and coexisting fibrosis. The psychological and social importance of effective tattoo removal is emphasized, particularly for young people seeking to disassociate from past experiences or affiliations.

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Introduction

Tattooing has been present in various eras of human civilization, with the earliest physical evidence found in a well-preserved mummy, nicknamed Ötzi, dating back to around 3258 BC in the South Tyrolean Alps [1]. While tattoos are primarily viewed as a form of art and body decoration among the general population, their functions and meanings are far more diverse, encompassing ritual, religious, and group affiliation purposes, as well as serving in disease healing, criminal and slave identification, and medical corrections after surgery [1, 2]. Tattoo prevalence varies among countries, but it is notably higher among younger populations. As tattoo prevalence increases, so does the number of people who regret their tattoos and seek tattoo removal, particularly in the Western world and among specific segments of the population. The estimated prevalence of having at least one tattoo is around 15–25% in Europe and 21–24% in the USA; 16–44% regret at least one of their tattoos, with a higher prevalence if they received it at a younger age; and 21–50% of them think about tattoo removal [1, 3, 4].

The most common reasons for tattoo regret and desire for removal include a change of lifestyle and personality to increase self-esteem, employment or a better chance of employment, pressure from family or a new partner, poor quality of tattoos, and rarer medical reasons, such as tattoo reactions [3, 5]. Besides the classic professional tattoos, there are other types of tattoos, including iatrogenic, traumatic, cosmetic, and amateur [6]. Amateur tattoos are quite common, with a prevalence of 17.6% in one US study [4]. These tattoos are performed using lower quality tattooing techniques and sometimes with unconventional types of ink that have not undergone safety regulations [7].

The gold standard of tattoo removal is short-pulsed lasers, such as quality-switched (QS) nanosecond lasers or picosecond lasers. The mode of action is based on the principle of selective photothermolysis, which involves the destruction of the target pigment without injuring the surrounding tissue [8]. The short-pulsed laser light is absorbed by the pigment, resulting in very rapid heating of the pigment particles, causing their thermal expansion and fragmentation, as well as the production of an acoustic wave that induces a fragmentation of the neighbor pigments [6]. Therefore, the mode of action includes a photothermal and a photoacoustic effect [9]. Fragmented particles are more easily phagocyted by macrophages and transported by the lymphatic system to the lymph nodes [9].

In our case report, a young female patient tattooed herself, using eyeliner ink and sewing needles, resulting in multiple tattoos spread all over her whole body, including her face. The tattoos were given impulsively during a difficult period in her life 2 years before. Due to a change in lifestyle, attitude, and desire for employment, the patient requested the removal of her tattoos.

Case Report

A 19-year-old female patient presented at the laser unit of the Dermatology Department at the University Hospital of Bern with 17 self-induced tattoos spread over her entire body, including her face and hands (Fig. 1a, b, 2a, c, e). These tattoos had been created using eyeliner ink and sewing needles in multiple sessions 2 years prior to her first consultation. Notably, there had been no spontaneous fading of the tattoos. The patient was significantly distressed by the presence of these tattoos, as she acquired them during a psychosocially challenging period of her life when she was a resident of a youth home where many of her peers were also engaged in self-tattooing. During her first dermatological exam, she referred that those tattoos would remind her of a stressful phase, and they could also put her at a disadvantage on

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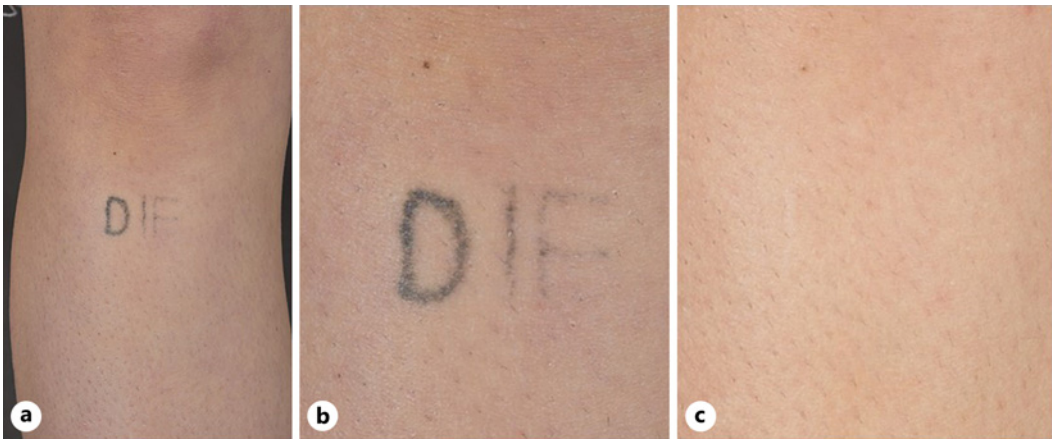

Fig. 1. Tattoo on the right proximal lower leg. **a** Overview before treatment. **b** Close-up before treatment. **c** Close-up of the proximal lower leg with clearance of the tattoo 15 months after the seventh session of QS Nd:YAG 1,064-nm laser treatment.

employment prospects, considering that they were in visible areas such as face and hands. No signs of complications, such as itching or changes in skin texture, were evident immediately after tattooing or during the subsequent course. The clinical assessment revealed amateur black, flat, and uneven tattoos in the periocular region, on the neck, chest, wrists, and right hand, as well as on both legs. One tattoo located on the fourth finger of the right hand was thickened, and dermoscopy indicated the presence of fibrosis.

To assess the efficacy of treatment, a test spot of the QS Neodymium-doped Yttrium Aluminum Garnet (Nd:YAG) 1,064-nm laser (MedLite C6, Cynosure, Westford, MA, USA) was performed on the right lower leg using a 4-mm spot size and a fluence of 3.0–3.5 J/cm^2. At the 6-week follow-up visit, a striking clearance of the pigment was observed, with no resulting side effects, such as hypo- or hyperpigmentation. Subsequently, 10 additional sessions of QS Nd:YAG 1,064-nm laser treatment were administered using a 4 mm spot size and fluence ranging from 3.0 to 7.0 J/cm^2. The spots were set one aside from the other; no overlap was performed. The fluence increased by around 10 percent each session. The desired fluence endpoint was set to achieve slight whitening along with a popping sound. As the patient exhibited a very high pain tolerance, this factor did not significantly influence the chosen parameters, as it often does during laser tattoo removal procedures. A 6–12 week therapy interval was chosen. These sessions led to a progressive fading, and on some tattoos, complete clearance. After seven sessions, the tattoos on the right lower leg and the neck disappeared completely (Fig. 2f). Three further treatment sessions were applied to the tattoos on the wrist, face, lower leg, and dorsal hand. Notably, tattoos located on the periocular, wrist, distal leg region and the finger exhibited slower fading. The tattoo on the finger with slight fibrosis persisted partially, while the other tattoos were removed completely (Fig. 2b, d). Posttreatment care included the application of sunscreen. Apart from a within 3 months self-limiting hyperpigmentation observed on the right lower leg, no adverse effects, such as hypopigmentation or scarring, were observed.

Discussion

In 1967, Goldman et al. [10] published the first series of tattoo removals with a QS Ruby 694-nm laser. Since then, short-pulsed lasers, including QS and picosecond lasers, remain the gold standard of treatments. For efficient fragmentation of the exogenous pigment, the

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wavelength of the chosen laser must be absorbed by the targeted pigment, which serves as the chromophore and deeply penetrates the dermis to reach the pigment. Longer wavelengths, such as 1,064 nm, penetrate deep into the dermis. Furthermore, 1,064 nm is best absorbed by black ink particles and is therefore the optimal wavelength for the elimination of black pigments and carbon particles. Melanin has an absorption peak at shorter wavelength and is therefore mostly bypassed with 1,064 nm. In the case of our patient, within 7–10 treatment sessions, the pigment, which was mainly composed of black carbon, on the cheek, the proximal legs, and the neck completely disappeared, while the pigment on the finger and ankles was a bit more resistant. These results are in line with previously described factors influencing the treatment response of tattoos [11, 12]. First, amateur tattoos are known to respond faster to laser treatment than professional tattoos due to their superficial location in the skin and their uneven application with less pigment [13]. Then, tattoos composed mainly of black carbon usually respond well to QS or picosecond Nd:YAG 1,064-nm laser removal due to the strong absorption of laser and its small size with ultrafine fragmentation after laser treatment [14]. Furthermore, the location of the tattoo influences the response to laser treatment. Tattoos on the proximal extremities as well as the face and neck area clear in fewer sessions than tattoos on the distal extremities due to better lymphatic supply and transport [9, 11, 12]. As also seen in our patient, tattoos with fibrosis induced by a poor injection technique, patient constitution, or inflammation are more difficult to remove. A lack of access by immune cells to the pigment due to the high density of fibrosis has been suggested as an explanation [12]. A possible method to speed up tattoo removal, even in the case of fibrosis, combines the therapy of fractional ablative lasers and short-pulsed lasers within one session to achieve transepidermal pigment elimination [15, 16]. In our patient, we did not perform this technique because of a good response to the classical treatment with fewer risks of side effects. A further possible method to speed up tattoo removal would be to perform several passes in one session [13].

In our patient, a test spot was performed. This is always important in cases where the type of ink or ink colors are not clearly known, as non-standardized color pigments can change their color at high temperatures [6]. Furthermore, treatment intervals of 2 months should be maintained to allow enough time for the immune system to eliminate the layer of fragmented particles [9]. This approach can reduce the number of sessions and decrease the occurrence of side effects, such as hyperpigmentation. Temporary hyperpigmentation was the only side effect that our patient experienced. When treating tattoos with laser, dermoscopy should be performed before each session to rule out post-inflammatory hyperpigmentation, which resembles a ghost tattoo (a shadow of the tattoo lines after removal).

This case is unique not only due to the removal of non-standardized tattoo ink from 17 different locations on the body, which highlights the factors influencing laser tattoo removal, but also because the health insurance company recognized the social and psychological risks associated with these tattoos. The removal of these tattoos was considered important for the psychological well-being, health, and personal development of this young patient.

Tattoos created at a younger age are often amateur tattoos, which raises concerns about complications because they may not be applied according to hygiene guidelines [4]. They also carry a higher risk of adverse events, especially infections and granulomatous reactions [4, 7]. Moreover, employing non-conventional tattoo ink with undisclosed

Fig. 2. Tattoos before and after treatment with QS Nd:YAG 1,064-nm laser. **a** Suborbital right side before treatment. **b** Clearance after 10 laser treatments and 3 months of follow-up. **c** Right hand before treatment. **d** Almost complete clearance on wrist and dorsal hand and residual pigment on the fourth finger after 10 laser treatments and 3 months of follow-up. **e** Pigment on the distal lower leg/ankle before treatment. **f** Almost complete clearance after 10 laser treatments and 3 months of follow-up.

ingredients as eyeliner in our scenario could potentially trigger unforeseen health complications in the skin. Additionally, systemic effects cannot be disregarded, especially when used in a large area, as approximately one-third of tattoo ink exits the skin through lymphatic transportation [17]. Carbon black, a common pigment in conventional tattoo ink, is produced via the incomplete combustion of heavy petroleum products, leading to the formation of polycyclic aromatic hydrocarbons [17]. According to the International Agency for Research on Cancer, carbon black is classified as a possible human carcinogen. Additionally, tattoos created impulsively and at a young age are more likely to lead to tattoo regret [3, 5]. Several studies indicated that the choice of tattoo symbol or motif is influenced by inner needs and cultural background, further emphasizing the psychological significance of tattoos [18, 19]. Despite the increasing acceptance of tattoos, negative associations persist [3, 5, 19, 20]. Tattoos in visible areas of the body are particularly troublesome in this regard, as our patient's experience illustrates. Negative perceptions of tattooed individuals include being seen as out of the mainstream, poor decision-makers, rebellious, antisocial, and even criminal [19–21]. While the desire for tattoo removal in this vulnerable young population is understandable and often supportive, the high cost associated with laser tattoo removal makes it inaccessible for many. Alternative treatment options, such as surgery, dermabrasion, salabrasion, chemical tattoo removal, infrared coagulation, cryotherapy, and radiotherapy, often result in significant side effects, including scarring [22]. It is in the interest of society to assist young people in leaving behind their impulsive and unstable phases of life or group affiliations and help them find employment and integrate into society. Therefore, offering effective tattoo removal options without persistent visible remnants is essential for individuals from all social backgrounds. In conclusion, this case report illustrates the successful removal of amateur tattoos created using black eyeliner ink by using a QS Nd:YAG 1,064-nm laser. The variables that impact the response to laser intervention are consistent with those elucidated in the context of professional tattoos. These variables include factors such as color, location on the body and in the skin, density, and the presence of fibrosis, resulting from suboptimal application techniques. Given the increased prevalence of amateur tattooing among adolescents, the provision of a safe and effective treatment modality is of paramount importance. This approach serves to protect them from the potential stigmatizing repercussions and unfavorable social perceptions. Moreover, it facilitates personal development by allowing individuals to distance themselves from their past, including emotional distress or group affiliations. The CARE Checklist has been completed by the authors for this case report, attached as online supplementary material (for all online suppl. material, see https://doi.org/10.1159/000538555).

Statement of Ethics

Written informed consent was obtained from the patient for publication of the details of her medical case and any accompanying images. This study protocol was reviewed, and the need for approval was waived by the Cantonal Ethical Committee of Bern, Switzerland.

Conflict of Interest Statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Author Contributions

S.M.S.J., K.H., S.B., M.A., and N.Y. designed the study and performed the acquisition, analysis, and interpretation of data. K.H., S.M.S.J., and L.F. wrote the manuscript. L.F. performed critical revision of the manuscript. All authors contributed to the article, approved the submitted version, and have read and agreed to the published version of the manuscript.

Data Availability Statement

The datasets presented in this article are not readily available due to ethical/privacy restrictions. Requests to access the datasets should be directed to the corresponding author.

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