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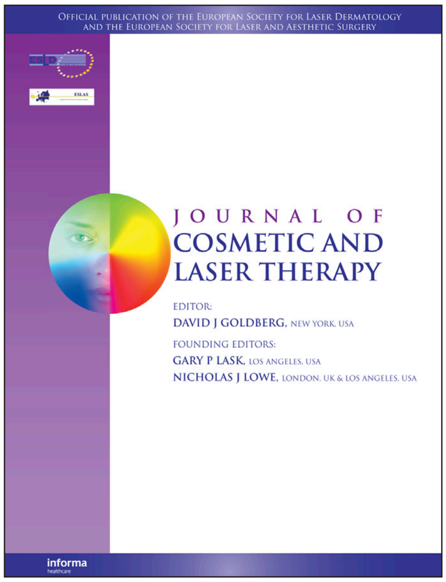

Fractional CO_2-laser are as effective as Q-switched-ruby-laser for the initial treatment of a traumatic tattoo

Anna-Theresa Seitz, Sonja Grunewald, Justinus Wagner, Jan C. Simon and Uwe Paasch

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Abstract

Background and Objective: Q-switched laser treatments are considered the standard method for removing both regular and traumatic tattoos. Recently, the removal of tattoo ink using ablative fractional lasers has been reported. Ablative fractional CO_2-laser and q-switched-ruby laser treatments were used in a split-face mode to compare the safety and efficacy of the two types of laser in removing a traumatic tattoo caused by the explosion of a firework.
Study Design/Patients and Methods: A male patient suffering from a traumatic tattoo due to explosive deposits over his entire face was subjected to therapy. A series of eleven treatments were performed. The right side of the face was always treated using an ablative fractional CO_2-laser, whereas the left side was treated only using a q-switched-ruby laser.
Results: After a series of eleven treatments, the patient demonstrated a significant lightening on both sides of his traumatic tattoo, with no clinical difference. After the first six treatments, the patient displayed greater lightening on the right side of his face, whereas after another five treatments, the left side of the patient's face appeared lighter. No side effects were reported.
Conclusions: In the initial stage of removing the traumatic tattoo, the ablative fractional laser treatment appeared to be as effective as the standard ruby laser therapy. However, from the 6th treatment onward, the ruby laser therapy was more effective. Although ablative fractional CO_2 lasers have the potential to remove traumatic tattoos, they remain a second-line treatment option.

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Key words: ablative fractional laser therapy, fireworks, q-switched-ruby laser, traumatic tattoo

INTRODUCTION

Traumatic tattoos resulting from fireworks lead to the forceful impregnation of the skin with gunpowder granules. To date, Q-switched lasers are the gold standard for the removal of regular tattoos represented by very small ink particles and as a second-line therapy for the removal of traumatic tattoos if surgical debridement can be applied [1]. However, particularly in the case of traumatic tattoos, the pigment particles are often too large to be removed using the q-switched-laser modality [2]. Additionally, there is a risk of triggering further explosions and deeper penetration of the gunpowder granules into the skin [3].

Recently, the removal of tattoo ink using an ablative fractional CO_2-laser (AFXL) in a mouse model as well as in two patients with a tattoo allergy has been reported [4;5]. The fractional treatment resulted in the physical removal of a portion of the tattoo ink. This was mediated by the further ablation and destruction of the tattoo pigment within microscopic ablation zones as well as by discharging the tattoo pigment using a microscopic exudative necrotic debris (MEND) shuttle. The latter method is similar to reactive perforating skin diseases. Here, we present the comparative outcomes for a patient with a full-face explosive tattoo who was treated using CO_2-laser-based AFXL therapy and q-switched-ruby laser therapy in a split-face mode.

METHODS/DESCRIPTION OF TECHNIQUE

A 44-year-old male patient presented with multiple gunpowder insertions as well as a corneal ulcer and a contusio bulbi after an accidental explosion of fireworks at his local shooting club. Intracranial injuries were excluded by CCT-scanning. Two days after the initial treatment by ophthalmologists and mechanical brushing performed at the oral and maxillofacial surgical clinic, the patient was referred for dermatological treatments.

Upon his first visit, multiple hemorrhagic and partially yellowed crusts were present on his entire face (Fig. 1). The i.v. antibiotic treatment using 750 mg of cefuroxim twice daily as well as topical treatment using a local disinfectant (Octenisept solution ®) initiated upon his first presentation were continued for 10 days. One month after the accident, after the initial skin healing, there was still a considerable amount of black-blue pigmentation in the dermis as well as multiple red scars, particularly on his right forehead. A small biopsy of his left nasolabial sulcus revealed chronic fibrotic partially granulomatous dermatitis with extracellular pigment present to a depth of 1 mm (Fig. 2).

Six-weeks post injury, the patient received his first laser treatment for the removal of the gunpowder pigment remaining in his facial skin. One hour prior to the laser treatment, a local anesthetic cream containing lidocaine and prilocain (EMLA®) was applied to the patient´s face under occlusion. With the written informed consent of the patient, the right half of his face was treated using a fractional CO_2-laser (10 600 nm Exelo$_2$, Alma Lasers GmbH, Erlangen, Germany) at a pulse duration of 2 ms and a fluence of 40 J/cm². The left part of his face was treated using a q-switched ruby laser (694 nm Sinon, Alma Lasers GmbH, Erlangen, Germany) at a fluence of 5.5 J/cm².

The patient received eleven treatments, which were performed at four-week intervals. The treatments were well tolerated, even when the laser fluencies were increased following the second treatment session, to 60 J/cm² (for the fractional CO_2-laser) and 7 J/cm² (for the ruby laser). Due to the injury to the patient's right eye, including a corneal ulcer, we refrained from placing a metal shield in direct contact with the eye. Therefore, the eye lid could not be treated. After each treatment, cold packs were applied for 1-2 days. The patient received a prophylactic anti-herpes treatment of 200 mg of acyclovir twice daily for 5 days after the laser treatments.

The q-switched ruby laser treatment was considerably more painful for the patient (8 out of 10 points on a visual analog pain score) than was the fractional CO_2-laser treatment (5 out of 10 points on a visual analog pain score), but the healing process after the former laser treatment was more rapid than that after the fractional CO_2-laser-treatment. Three days after each treatment, there was considerably crusting and erythema on his right side, whereas the left side was nearly completely healed (Fig. 3).

Following a series of six treatments, the patient exhibited significant lightening on both halves of his traumatic tattoo, as well as a flattening and lightening of his scars. There was no significant difference in the amount of lightening observed on the two sides of the patient's face (Fig. 4). After another five treatments, the left sight of the patient's face appeared slightly lighter than the right side.

DISCUSSION

Q-switched lasers are first-line options for treating iatrogenic skin pigmentation after debridement, if possible, has been performed. Q-switched laser therapy causes the targeted destruction of small tattoo ink particles using the mechanism of selective photothermolysis [6]. The tattoo ink is removed by phagocytes and eliminated through trans-epidermal and/or lymphatic transport. However, in the case of traumatic tattoos, the size of the explosive particles might be too large to achieve complete removal.

In contrast, fractional ablative laser therapy causes the creation of thousands of small channels in the skin called microscopic treatment zones (MTZs) or “tors” (temporary openings of the epidermal barrier, tors = German for “gates”) that heal without any scarring. In addition, there is a specific spatiotemporal sequence of wound healing after AFXL treatment that is characterized by a stereotypical inflammation process involving the expression of various cytokines and heat-shock proteins, as well as an active trans-dermal elimination mechanism (Fig. 5) that discharges debris in addition to foreign bodies similar to those seen in perforating dermatoses [7].

Data obtained using an animal model demonstrated the potential of fractional ablative CO_2-lasers to remove tattoo pigments to a certain extent [5]. The histological assessment in this study showed the removal and destruction of tattoo pigment in the microscopic ablation zones and subsequent discharge of the tattoo pigment in exudative necrotic debris. The clinical removal of tattoo pigment using a combination treatment with a fractional erbium:YAG laser and a q-switched-ruby laser was reported for two patients who had developed an allergy to their tattoo [4]. In addition to the greater extent of tattoo removal, fewer side effects were reported after a combinatorial treatment with a q-switched ruby laser and an ablative fractional laser [8]. Moreover, in addition to lightening tattoos, fractional CO_2-laser therapy also softens and smoothes the accompanying scars. Patients with traumatic tattoos could therefore also benefit from an aesthetic enhancement of their concomitant scars. In contrast, q-switched ruby laser treatments are known to carry the risk of significant scaring [6].

This study demonstrated that ablative fractional treatment appeared to be as effective as the standard ruby laser therapy during the first series of treatments (up to the sixth treatment) to remove particles that were in the skin as the result of a traumatic tattoo. After six treatments, there appeared to be an advantage in using the q-switched-ruby laser. This result might be attributed to the remaining pigment particles being small. The potential of fractional laser removal of traumatic tattoos will be addressed in future studies.

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FIGURE LEGENDS

Figure 1. Patient on days two (A), eight (B) and thirty (C) after the injury.

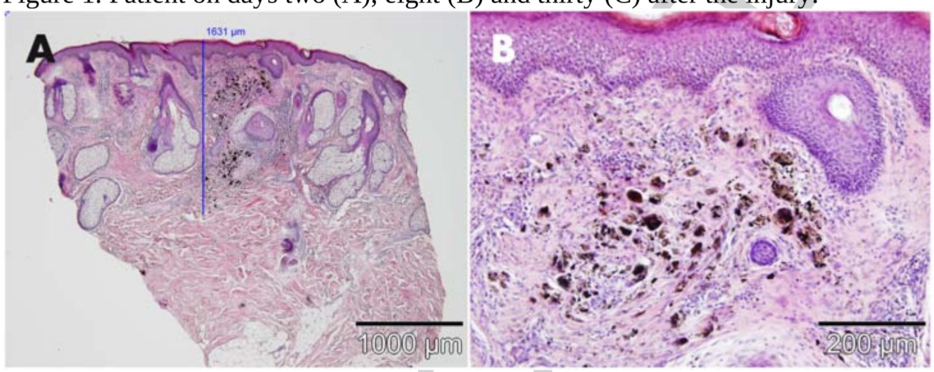

Figure 2. Lower- (A) and higher-magnification (B) images of a skin biopsy of the left nasolabial sulcus, showing areas filled with large black particles surrounded by inflammatory infiltrates, foreign-body granulomatosis, and fibrosis.

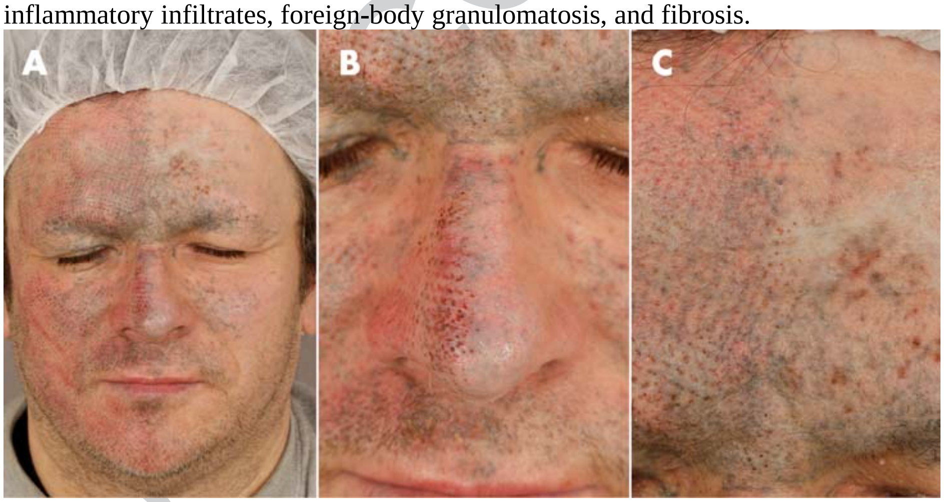

Figure 3. Patient three days after laser treatments, with widespread crusting on the right side of his face (A,B,C), which represented the active expulsion of MEND.

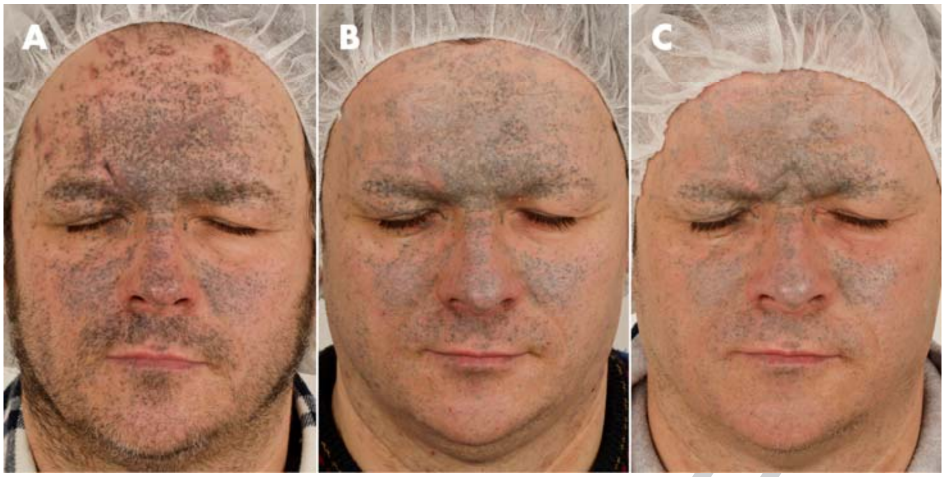

Figure 4. Patient before the 1st (A), after the 3rd (B) and after the 6th (C) treatment.

Figure 5. Patient before the 12th (A,B,C) treatment.

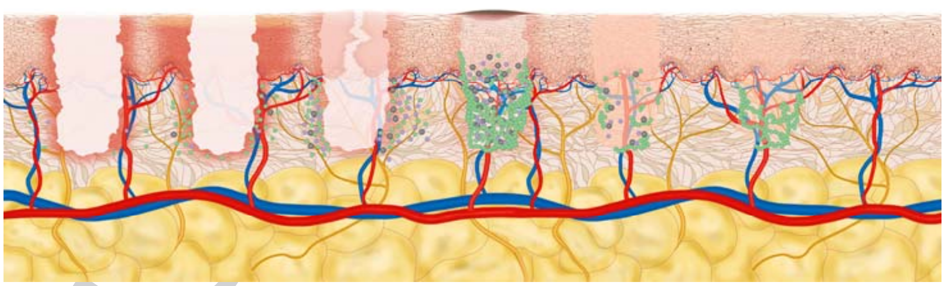

Figure 6. Schematic illustration of the spatio-temporal sequence of wound healing that is induced by ablative fractional laser therapy [9]