
Case report

Immediate cutaneous hypersensitivity after treatment of tattoo with Nd:YAG Laser: a case report and review of the literature

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Background: To our knowledge this is the first reported case of an immediate cutaneous reaction to Q-switched neodymium:yttrium-aluminum-garnet (Nd:YAG) laser tattoo removal. A 26-year-old female presented with two 6-year-old tattoos placed at different times. These were of different colors and had remained entirely asymptomatic since placement. There was a Mardi Gras mask on her thigh and a Tasmanian devil on her chest. With laser treatment of the Tasmanian devil, she experienced no untoward effects. However, with treatment of the Mardi Gras mask tattoo, she developed an extensive urticarial and indurated reaction 30 minutes posttreatment. The identical reaction occurred twice with subsequent laser treatments. Dermatology consulted allergy to provide prophylaxis against possible systemic reaction with subsequent Nd:YAG laser therapy. The patient was treated with 3 days of prednisone, cetirizine, and ranitidine before subsequent laser treatments. Prophylactic treatment suppressed all subsequent reactions to laser therapy.

Results: Delayed hypersensitivity to tattoo pigments occurring days to weeks after placement is well documented. There are no previous reports of immediate hypersensitivity during placement or laser removal. However, there are two previous reports of local and systemic delayed reactions after laser therapy.

Conclusions: As far as we know, this is the first case report of immediate hypersensitivity after Nd:YAG laser treatment of a tattoo. Prophylactic treatment with steroids and antihistamines prevented reactions with subsequent laser treatments. Reactions after laser removal are rare, but may increase as popularity of skin art increases with the need for subsequent removal.

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INTRODUCTION

There has been a dramatic increase in the popularity of the age-old art of tattooing in recent years. This practice has not only spanned the millennia but also many cultures and is represented by different styles and fads. The tattoo machine is powered by an electromagnet and is not dissimilar to a sewing machine in its action. The electromagnet causes the needle to oscillate back and forth dipping into an ink well and depositing the dye into the dermis of the skin. Ingredients of tattoo pigments are often unknown as professional tattoo pigment suppliers guard their recipes closely. Professional artists use metallic dyes, some with organic components,^{1–3} whereas amateur artists use India ink or graphite. In a recent study, 41 tattoo pigments were analyzed and results revealed that many of the inorganic metallic dyes are being replaced with industrial organic pigments including azo compounds and aromatic amines.⁴ Amazingly, despite use of pigments

containing metallic and organic components, professional tattoo pigments are relatively inert with only rare cutaneous reactions. With this surge in popularity, tattoos are often placed impulsively with subsequent need for removal.

The currently most effective method of tattoo removal uses Q-switched lasers capable of targeting pigment-containing cells by producing short bursts of intense energy that disrupt pigment particles without affecting surrounding cells. This quality makes Q-switched lasers ideal for tattoo removal. Currently, in the United States there are three approved Q-switched lasers including Q-switched ruby laser (QSRL), neodymium:yttrium-aluminum garnet (Nd:YAG), and alexandrite laser.⁵

CASE PRESENTATION

This is the first case, to our knowledge, of an immediate cutaneous reaction to Nd:YAG laser tattoo removal. A 26-year-old female had two 6-year-old tattoos placed at different times. These were of different colors and had remained entirely asymptomatic since placement. There was a Mardi Gras mask on her thigh and a Tasmanian devil on her chest. With laser treatment of the Tasmanian devil she experienced no untoward effects. However, approximately 1 month later, she developed an extensive urticarial and indurated reaction 30 minutes after treatment of the Mardi Gras mask tattoo with

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Table 1. Nd:YAG Laser Settings Used for Treatment of Tattoo Pigments in Vivo and in Vitro

Tattoo color	Wave length	Energy	Frequency	Spot size
Sumi black	1064 nm	2 joules/cm ²	10 Hz	8 mm
Magenta	532 nm	1.6 joules/cm ²	10 Hz	6.0 mm
Special green	650 nm	1.5 joules/cm ²	1 Hz	3 mm
Turquoise	650 nm	1.5 joules/cm ²	1 Hz	3 mm

These settings can be manipulated when using a Nd:YAG laser. Frequency is defined as the number of oscillations per second which is also known as hertz (Hz). Energy is defined as the capacity for doing work and is measured in joules per unit area. A joule is the heat or energy expended by an ampere flowing through an ohm for 1 second (1 calorie = 4.187 joules).

Nd:YAG laser as outlined in Table 1. Although not well depicted, note the urtication, erythema, and induration surrounding the Mardi Gras mask tattoo immediately after laser treatment (Fig 1). A biopsy was not performed at this time as the lesion resolved spontaneously within a short period of time. She was not taking any other medication that could account for this reaction. Initially, it was postulated that the patient reacted to the treatment of the red pigment with wavelength of 532 nm; therefore, the patient was treated only with wavelength of 1,064 nm on the second treatment. However, the identical reaction recurred despite modification of the wavelength. Each laser treatment was separated by approximately 4 weeks in time. The dermatology service consulted allergy to provide recommendations for prophylaxis against possible systemic reaction with subsequent laser therapy. The patient was treated with 3 days of prednisone, cetirizine, and ranitidine before subsequent laser treatments. Prophylactic treatment suppressed all subsequent reactions to laser therapy.

We learned that there were two tattoo parlors in Wichita Falls where the patient may have had the tattoos placed. The most likely tattoo parlor was contacted. The owner was unable to find a record of tattoo placement as the industry is only required to keep records for 1 to 2 years. However, we were able to obtain tattoo pigments from the supplier. After some initial resistance from the supplier, one ounce of four different tattoo pigments were purchased including magenta,

turquoise, special green, and sumi black. These were the suspected colors in the patient's tattoo. As the patient did not have immediate hypersensitivity until after laser therapy, it is possible that laser therapy altered the pigments, resulting in new antigenic determinants. Therefore, following a published protocol,⁶ using Nd:YAG laser, samples of each of the pigments were treated in vitro using the same wavelength as the patient had received in previous laser treatments (Table 1). Q-switched Nd:YAG laser was passed evenly over the entire specimen in a Petri dish through a Vigilon cover (Bard Medical, Covington, GA) for 30 nanoseconds. Epicutaneous skin testing was performed with the original pigments and the irradiated samples. Skin testing to both groups of samples was negative.

DISCUSSION

There are several plausible reasons that could explain why the skin test was negative. First, we may not have obtained the correct pigment for testing. There are many suppliers of tattoo pigments and each supplier makes hundreds of different pigments. Second, local tattoo artists alter many pigments by mixing colors—sometimes from different suppliers. Third, pigments may contain direct mast cell irritants and the urticarial reaction may not be immunoglobulin (Ig)E-mediated.

Delayed hypersensitivity to tattoo pigments occurring days to weeks after placement is well documented. There are no previous reports of immediate hypersensitivity during placement or laser removal. However, there are two previous reports of local and systemic delayed reactions after laser therapy. The first published report included two cases.⁷ A generalized eruption occurred 2 to 3 weeks after treatment with both QSRL and Nd:YAG lasers. The second patient developed generalized urticaria 6 days after QSRL treatment. Prophylactic therapy with prednisone and hydroxyzine suppressed reaction with the next laser therapy. The second article reported worsening of a tattoo pigment delayed eczematous reaction 3 to 4 weeks after therapy with CO₂ laser.⁸

Solar-induced urticaria should be considered in the differential diagnosis. It is well known that sunlight exposure can cause pruritis, erythema, and wheal formation. Alora and Taylor⁹ presented a case report of a patient who developed laser-induced urticaria during her work-up for solar urticaria. The author proposed using an argon-pumped dye laser for diagnosis of solar-induced urticaria in patients who did not react to standard light testing with a slide projector as well as



Figure 1. Mardi Gras mask tattoo 30 minutes after Nd:YAG laser treatment.

ultraviolet A and B broadbuls. Solar urticaria is not the likely cause of our patient's reaction for two reasons. First, the history was not consistent with solar urticaria. Second, the patient did not react to laser treatment of the Tasmanian devil tattoo in contrast to repeated reactions to Nd:YAG laser treatment of the Mardi Gras mask. If physical stimuli were the cause of her symptoms, it would be expected that she would develop urticaria after treatment of both tattoos.

There are several studies of microscopic analysis before and after laser therapy.^{6,10,11} Before irradiation, pigment is located in lysosomes of fibroblasts and occasionally in mast cells and macrophages in a perivascular distribution. Immediately after laser therapy, pigment-containing cells can be damaged with membrane disruption and vacuolization. With disruption of the cell membrane, the tattoo pigment particles are then located outside the cell.¹⁰ Large vacuoles are seen in the immediate postirradiation period. Immediately after laser therapy, the vacuole is lined with residual pigment and compressed cellular components which occurred after the pigment particles are disrupted.¹¹

The mechanism whereby laser therapy functions is unknown, but one proposed theory about the fate of pigment particles is that absorption of specific wavelengths by pigment containing cells results in selective thermal destruction of that cell. Vacuoles result from explosion of cells attributable to the generation of thermal energy and sound waves. Residual pigment particles are rephagocytized after 1 week.¹¹ Nonpigment-containing cells seem to be unaffected.

We propose three possible mechanisms for immediate hypersensitivity in this patient. First, tattoo pigments are intracellular and sequestered from the immune system. Laser therapy causes explosion of pigment particles with lysis of the cells and subsequent extravasation of particle remnants into the extracellular space where interaction with the immune system occurs. This reaction may be IgE-mediated or non-IgE-mediated. Secondly, pigments are known to reside in mast cells and laser-induced lysis of mast cells could account for immediate hypersensitivity reactions. Finally, antigenic determinants may be altered by the laser therapy itself, although there is no evidence to support this theory.

CONCLUSION

As far as we know, this is the first case report of immediate hypersensitivity after laser treatment of a tattoo. Prophylactic treatment with steroids and antihistamines prevented reactions with subsequent laser treatments. If the exact pigment

can be obtained, skin testing might be useful in identifying the antigen. However, informed consent should be obtained as skin prick testing can result in a small but visible pinpoint tattoo. Reactions after laser removal are rare, but may increase as popularity of skin art increases with the need for subsequent removal.

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