

Persistent Tattoo Allergy Treated with Q-switched Neodymium: Yttrium Aluminium Garnet (Nd:YAG) Laser

Anne Fay A. Alvañiz^{1*}, Julius G. Gatmaitan², Johannes F. Dayrit¹

¹Department of Dermatology, Research Institute for Tropical Medicine, Alabang, Muntinlupa City, Metro Manila, Philippines

²Gatmaitan Medical and Skin Clinic, Baliuag, Bulacan, Philippines

Correspondence: Anne Fay A. Alvañiz; Department of Dermatology, Research Institute for Tropical Medicine, Alabang, Muntinlupa City, Metro Manila, Philippines; Email: fayalvaniz@gmail.com

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Abstract: Tattoos are widely used for cosmetic and therapeutic purposes; however, they may lead to adverse reactions. Tattoo allergies can have a substantial impact on the skin and the patient's quality of life. Managing such allergies, particularly in older tattoos containing complex pigments, presents a significant therapeutic challenge. We report the case of a 60-year-old female with a persistent tattoo allergy. Initial treatments with corticosteroids and immunomodulators provided only temporary relief. She subsequently underwent six monthly sessions of Q-switched Neodymium:Yttrium-Aluminium-Garnet (Nd:YAG) laser tattoo removal, which resulted in marked pigment lightening and sustained symptom improvement without adverse effects. This case highlights the efficacy and tolerability of Q-switched Nd:YAG laser therapy as a viable long-term treatment for tattoo allergy.

Keywords: Tattoo allergy, Q-switched Nd:YAG laser, Delayed hypersensitivity reaction, Tattoo complications

Introduction

Tattooing involves implanting permanent pigments and additives into the dermis. While primarily used for cosmetic purposes, it also has therapeutic applications, including camouflaging vitiligo, reconstructing the breast areola after surgery, concealing hair loss, and improving the appearance of surgical scars [1]. The increasing prevalence of tattoos worldwide has been accompanied by a rise in adverse reactions. Adverse reactions may involve impaired wound healing, infections, toxic or potentially mutagenic effects, granulomatous inflammation and allergic reactions. [2] Pigment particles and ink

components deposited in the dermis can trigger immune or toxic reactions, often presenting as mild symptoms such as pruritus, swelling, or hair loss within the first month in approximately one in five individuals [3]. More persistent and severe reactions are less common, typically appearing later and affecting about 6%–8% of tattooed individuals [4,5]. The exact prevalence of tattoo allergies in Asia remains unclear; however, one study in India reported 50 allergic reactions diagnosed among 39 patients, with red (53.9%) and black (33.3%) pigments being the most commonly implicated [6]. Management options include topical or intralesional corticosteroids and, in some cases, oral medications such as

hydroxychloroquine or allopurinol. More invasive interventions, such as surgical excision and laser therapy, must be approached cautiously due to the potential risk of permanent scarring [7]. This report describes a case of a 60-year-old female who developed a persistent tattoo allergy following a scar-covering tattoo but achieved successful resolution after treatment with a Q-switched Neodymium:Yttrium-Aluminum-Garnet (Nd:YAG) laser.

Case Report

A 60-year-old female presented with pruritus, redness, and scaling over a scar-covering tattoo on her left leg. Fifty years prior to consultation, she sustained an injury that resulted in a scar on the same leg. Two years before presentation, she received a tattoo consisting of a red rose and black leaves to conceal the scar. Two weeks before consultation, she developed induration, erythema, and pruritus (intensity 8/10, interfering with sleep). The lesion progressed to an indurated, thick plaque with excoriations (**Figure 1A**), suggestive of a tattoo allergy.

Clinically, the inflammatory reaction involved areas containing both red and black pigments.

Initial treatment included oral methylprednisolone 16 mg once daily for one week, tapered to 8 mg once daily for the subsequent two weeks, along with clobetasol 0.05% ointment and tacrolimus 0.1% ointment, which provided only temporary relief. She subsequently received intralesional triamcinolone acetonide (20 mg/ml, 0.1 ml injected 1 cm apart for a total of 1.5 ml), but there was no significant improvement in symptoms. A 4 mm skin punch biopsy was performed, revealing epidermal acanthosis with pseudoepitheliomatous hyperplasia and spongiosis (**Figure 2A**). The dermis demonstrated subepidermal clefting, pigment-laden macrophages, and thickened eosinophilic collagen bundles (**Figure 2B**). Red and black tattoo pigments were scattered throughout the dermis and surrounded by a dense inflammatory infiltrate of lymphocytes, histiocytes, and plasma cells (**Figure 2C**). Based on the clinical and histopathological findings, the patient was diagnosed with a tattoo-related allergic reaction.



Figure 1. Cutaneous examination showing (A) an indurated plaque with excoriations over the tattoo prior to any treatment; (B) baseline lesion appearance before the 1st laser session; (C) One month after the 6th laser session; (D) Two months after the 6th laser session; (E) One year after the 6th laser session.

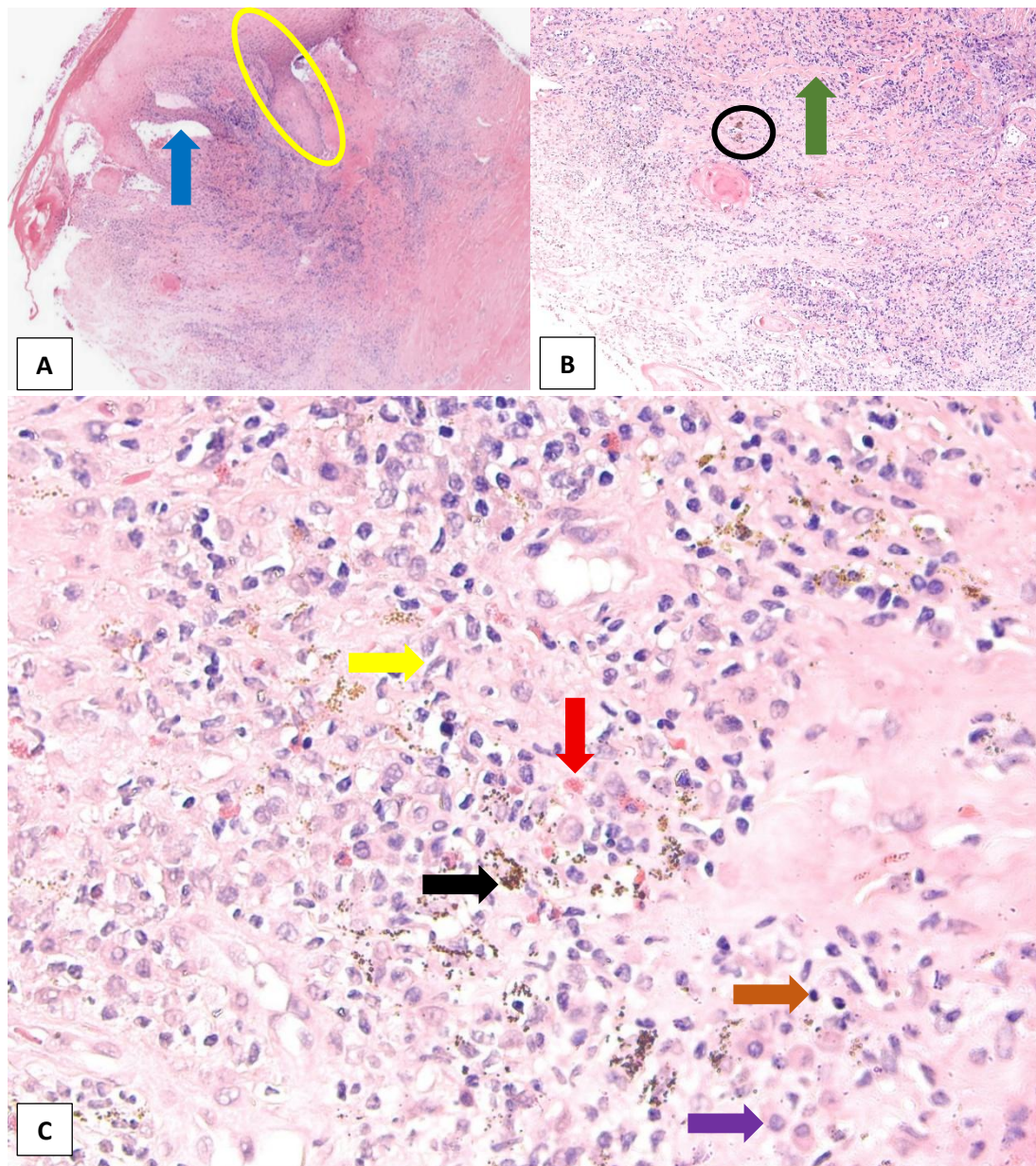


Figure 2. Histopathological examination showing: **(A)** acanthosis of the epidermis with pseudoepitheliomatous hyperplasia (yellow oval) and subepidermal clefting (blue arrow); **(B)** pigment-laden macrophages (black circle) and eosinophilic thickened collagen bundles (green arrow) [H&E, ×100]; **(C)** red tattoo pigments (red arrow) and black tattoo pigments (black arrow) dispersed throughout the dermis, surrounded by a dense inflammatory infiltrate of lymphocytes (orange arrow), histiocytes (yellow arrow), and plasma cells (purple arrow) [H&E, ×400].

Different treatment options were discussed, and the patient opted for laser therapy after the associated risks were thoroughly explained.

She underwent six monthly sessions of Q-switched Nd:YAG laser tattoo removal (Tri-Beam

Premium, Jeisys Medical, Korea) under topical anesthesia with occlusion (10.56% lidocaine). A dual-wavelength approach was used: 532 nm (1–1.2 J/cm², 4 mm spot size, 2 Hz, 5–10 ns pulse duration, 20% overlap, single pass) for the red pigment, achieving an endpoint of gray

blanching, and 1064 nm (4–6 J/cm², 4 mm spot size, 2–6 Hz, 5–10 ns pulse duration, 20% overlap, single pass) for the black pigment, achieving an endpoint of slight frosting. She was also prescribed oral levocetirizine 5 mg once daily and topical halobetasol 0.05% ointment twice daily.

After each session, there was progressive lightening of the tattoo pigments, along with marked reduction in redness, scaling, and pruritus (**Figure 1B to 1D**). No post-laser complications were observed. At one-year follow-up after the final laser session, there was significant lightening of the tattoo, resolution of inflammation, and minimal residual pruritus (**Figure 1E**). Written informed consent was obtained for the publication of clinical details and photographs.

Discussion

Allergic reactions to tattoo pigments typically present with nonspecific symptoms such as tenderness, swelling, and papules or nodules, which may be asymptomatic or pruritic. These reactions are often accompanied by crusting and excoriations resulting from persistent itching. Among all tattoo pigments, red is the color most frequently associated with allergic reactions [8]. Over recent decades, organic pigments such as azo compounds, quinacridones, and phthalocyanines have replaced mineral pigments. Case reports suggest that azo and quinacridone pigments may act as sensitizers, particularly in red tattoos [9]. Delayed hypersensitivity to tattoo ink is possibly caused by long-term ink metabolism or interactions between ink antigens and dermal carrier proteins [10]. However, the exact pathophysiology remains unclear due to the unidentified allergen [10–12].

Allergic reactions to tattoos are classified as late reactions, occurring months or even years after tattooing [13], as seen in our case, where the patient's symptoms appeared two years after the

procedure. No pain, increased local temperature, oozing, or ulceration were observed, effectively ruling out infection. While patch testing may be helpful in such cases, tattoo-related allergic reactions are often complicated by frequent false-negative results due to the low dispersibility of tattoo pigments and the difficulty in obtaining suitable test solutions [6]. A definitive diagnosis relies on histopathological evaluation of a skin biopsy, which also assists in differentiating other potential conditions based on characteristic histological patterns [14].

In a study by Silvestre and González-Villanueva [13], interface dermatitis, characterized by a predominantly lymphocytic band-like inflammatory infiltrate, with or without associated spongiotic dermatitis, was reported as a common histological finding in allergic reactions to tattoo ink. This band-like inflammatory infiltrate involves the basal layer of the epidermis and extends into the papillary dermis. In numerous cases, pseudoepitheliomatous hyperplasia is also present, and in more advanced cases, dermal fibrosis is often observed. Similar findings were noted in our case, including pseudoepitheliomatous hyperplasia and spongiosis in the epidermis, subepidermal clefting, pigment-laden macrophages, and red and black tattoo pigments surrounded by a dense inflammatory infiltrate of lymphocytes, histiocytes, and plasma cells. Eosinophilic collagen in the dermis, indicative of dermal fibrosis, was also present. The absence of granulomatous features in our patient supports the exclusion of systemic granulomatous diseases and infectious etiologies.

To date, the treatment and management of tattoo reactions remain challenging [6]. Complete removal of the offending pigment is often necessary to achieve lasting symptom resolution. Initial management typically involves topical or intralesional corticosteroids to alleviate inflammation and control symptoms, though results are often limited and

unsatisfactory. In persistent or severe cases, interventions such as laser ablation or surgical excision may be considered to eliminate the causative allergen, although there is no consensus on the optimal approach. While conventional surgical excision allows for complete removal of dermal tattoo pigments, its use is limited to small tattoos and specific anatomical sites due to the high risk of scarring [12]. Techniques such as dermabrasion or dermatome shaving may alleviate symptoms by removing affected tissue, but they are generally effective only for superficial pigment. More aggressive shaving can result in prolonged healing times and potential scarring [10]. Currently, lasers are the preferred treatment for tattoo removal [15]. In our case, multiple local and systemic immunosuppressive therapies had already been attempted without success, and the patient opted for laser tattoo removal due to the high risk of scarring associated with surgical excision.

The Q-switched Nd:YAG laser is currently considered a highly effective method for tattoo removal, offering excellent results with minimal risk of scarring or hypopigmentation [16–18]. It operates on the principle of selective photothermolysis, wherein a chromophore is heated for a duration shorter than its thermal relaxation time, allowing targeted destruction without damaging surrounding tissue [19,20]. Multi-colored tattoos require lasers with different wavelengths. Studies have shown that the 1064 nm picosecond laser demonstrates superior efficacy for black tattoo removal, while the 532 nm picosecond laser is significantly more effective for red pigments [21].

Allergic reactions to tattoos may be treated using the Q-switched Nd:YAG laser, which targets and removes the offending pigments [7,15]. Previous reports have described the use of Q-switched Nd:YAG lasers for managing tattoo-related allergic reactions, though these cases are limited and primarily

focus on red pigments. For instance, van der Bent and van Doorn [7] reported the resolution of a delayed allergic reaction to a red cosmetic tattoo using a 532 nm wavelength combined with oral methotrexate. Lee et al. [15] described a refractory allergic reaction to a red tattoo successfully treated with a picosecond Nd:YAG laser, followed by fractional carbon dioxide laser and intralesional corticosteroid injections. Laser-induced photomechanical breakdown of tattoo pigments may exacerbate immune reactions during treatment [7], though these responses have been successfully prevented in some cases with topical, oral, or intralesional corticosteroids [7,15]. In our case, topical corticosteroids were administered concurrently.

While these cases demonstrate the efficacy and tolerability of laser therapy, a standardized approach to managing tattoo allergy remains undefined. Our case contributes to this limited evidence by demonstrating the successful use of both 532 nm and 1064 nm wavelengths in a patient with allergic reactions to a multicolored tattoo, involving both red and black pigments. No adverse events were noted.

Conclusion

Even though the use of lasers for allergic reactions associated with tattoo removal is well known, a standardized management approach remains undefined. Our case adds to the limited evidence by demonstrating that Q-switched Nd:YAG laser treatment is an effective and well-tolerated option for managing persistent tattoo allergy. Successful treatment was achieved using both 532 nm and 1064 nm wavelengths for a multicolored tattoo involving red and black pigments, with no adverse events observed. Therefore, a trial of Q-switched Nd:YAG laser therapy may be considered in cases of allergic reactions to tattoos that are refractory to medical therapy.

Acknowledgement

None

Potential Conflict of Interest

The authors declare no potential conflicts of interest.

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