

Evaluation of Amateur and Professional Tattoo Removal by the Q Switched Nd:YAG Laser

Nibras A. A. Hindy

Department of Dermatology and Venereology, Al-Imam Al-Sadiq Teaching Hospital, Hilla-IRAQ.

Abstract

Background: A tattoo is visible and permanent pigmentation of the skin secondary to the deliberate or accidental deposition of exogenous pigment within the dermis. A variety of procedures have been used to remove tattoos, such as laser therapy, surgical excision, and dermabrasion. QS laser treatment can result in good cosmetic outcomes and complete or near-complete removal of many unwanted tattoos.

Objective: to evaluate the QS Nd:YAG laser effects for amateur and professional tattoos removal.

Materials & Methods: The study was done on 293 tattoo lesions from 176 patients (in both genders), there were 239 amateur tattoos (136 patients) and 54 professional tattoos (40 patients). Tattoos on a wide range of body sites (limbs, feet, face, chest, shoulders and legs) were treated. Ages were between 17- 60 years. In this work, tattoos were divided to amateur and professional tattoos. A Q-switched Nd:YAG laser system was used throughout this study. All tattoos containing black and blue pigment were treated at 1064 nm. Tattoos containing red pigment were treated at 532 nm. Treatment was scheduled at 4-6 weeks intervals and continued until maximum clearance of the tattoo was achieved, and the number of sessions varies from one to five sessions. For assessment of degree of lightening the method proposed by Lanigan was used: grade 1, complete response (> 95% lightening); grade 2, excellent response (76–95% lightening); grade 3, good response (51–75% lightening); grade 4, fair response (26–50% lightening); grade 5, poor response (0–25% lightening).

Results: Amateur tattoos were often more numerous than professional tattoos. Eighty per cent of tattoos (198 of 239) were clinically clear at the time of analysis, this included 70.7% (169 of 239) which were ≥ 95% clear. Overall 56.6% of amateur tattoos were clinically clear after two treatments, and 82% (110 of 134) were clinically clear after 2-3 treatments, while the clinical clearance rate was 40% after six treatments for professional black tattoos. It is anticipated that response rates will increase when tattoos at an early stage of treatment receive further treatments, and P value was (0.004) which means that there is significant difference between two groups.

Conclusion: Amateur tattoos generally require fewer treatment sessions and the response is better than professional tattoos.

Keyword: *Q-switched Nd: YAG laser, Amateur tattoo, Professional tattoo.*

Introduction

Tattoo removal is an increasingly common office procedure often performed by dermatologists with special training in tattoo removal. A variety of procedures have been used to remove tattoos, such as laser therapy, surgical excision, and dermabrasion. Quality-switched (Q-switched, QS) lasers are the standard of care for tattoo removal and treatment can result in good

cosmetic outcomes. A tattoo is visible and permanent pigmentation of the skin secondary to the deliberate or accidental deposition of exogenous pigment within the dermis. There are five major subtypes of tattoo [1,2]:

- **Professional tattoos** – are decorative tattoos placed by professional tattoo artists using a handheld tattoo gun that delivers uniformly deep dense dermal injections of ink. Pigment is deposited more deeply in

the dermis than most amateur tattoos, which can make professional tattoos more difficult to remove. Over time, the ink colors fade as a result of pigment migration into the deeper dermis and to regional lymph nodes via lymphatic's.

●**Amateur tattoos** – are decorative tattoos performed by nonprofessionals, and are often placed by using a handheld needles that deliver India ink or carbon injected at variable depths into the skin . Amateur tattoos are most often black and may contain ingredients such as charcoal, soot, or pen ink and are more superficially placed than professional tattoos.^[2-4]

Cosmetic tattoos - are often applied freehand by cosmetologists to provide permanent makeup in areas where one would apply eyeliner, lip liner, or eyebrow pencil.

Medicinal tattoos- are small gray or blue-black markings placed by medical personnel to designate radiotherapy fields or port placement sites. Similar to amateur tattoos, they are typically composed of a sparse amount of India ink or carbon pigment.

Traumatic tattoos- result from deposits of foreign particles such as metal, glass, dirt, and carbon-containing particles into the skin following mechanical penetration, often follow blast injuries or trauma.^[4,5]

Laser tattoo removal is based on the concept of selective photothermolysis. This theory, first described in the early 1980s by Anderson and Parrish, revolutionized the landscape for laser therapy by allowing for precise tissue targeting, thus ameliorating the risk of dyspigmentation and scarring associated with earlier therapies such as depigmenting agents, cryotherapy, and dermabrasion^[6-10]

The longer wavelength of the Q-switched Nd:YAG laser at 1064 has proven to be more effective in removal of black tattoo, with better penetration of the dermis, less likelihood of absorption by epidermal melanin, and a reduced risk of hypopigmentation. The improved efficacy is attributed to the longer wavelength, higher fluence, and shorter pulse width, and the Nd/YAG laser, at 532nm, has also been used successfully on red tattoos.^[4,11,12]

Patients and Method

262 consecutive tattooed patients were treated at my private dermatology clinic, between June 2010 and

December 2018. From these 262 patients, 66 were excluded because they did not come back after the first laser appointment; therefore a total of 176 patients (159 male and 17 female), and 293 tattoos was included in our study. The patients were aged 17-60 years with skin types III-IV. There were 239 amateur tattoos (136 patients) and 54 professional tattoos(40 patients). Tattoos on a wide range of body sites (limbs, feet, face, chest, shoulders and legs) were treated.

A Q-switched Nd:YAG laser system was used throughout this study. The operating characteristics of the laser were as follows: wavelength 1064nm and 532nm, with spot sizes 3mm in diameter and frequency 6 Hz. The pulse duration was ≤ 15 ns and the energy output 800mj and 500mj respectively. Radiation was delivered via an articulated arm and hand-piece, at a fixed energy density of 10 J/cm². This energy level was selected on the basis of a previous report which showed that energies of 10 or 12 J/cm² cleared tattoos more effectively than lower energy levels^[13].

All tattoos containing black and blue pigment were treated at 1064 nm. Tattoos containing red pigment were treated at 532nm. Treatment was scheduled at 4-6 weeks intervals and continued until maximum clearance of the tattoo was achieved, and the number of sessions varies from one to five sessions. .

Pretreatment evaluation included a clinical description of the site, shape, color and density of each tattoo and photographs taken at each visit, progress was assessed by estimating the percentage area of the tattoo that visibly clear.

For assessment of degree of lightening the method proposed by Lanigan^[14] was used: grade 1, complete response (> 95% lightening); grade 2, excellent response (76–95% lightening); grade 3, good response (51–75% lightening); grade 4, fair response (26–50% lightening); grade 5, poor response (0–25% lightening). The occurrence of adverse events, such as itch, pain, infection, hyperpigmentation and hypopigmentation, were recorded at each visit.

The Nd/YAG laser pulse, at 1064 nm produces an immediate ash white discoloration and slight elevation of the tattooed skin at the site of impact. These changes are accompanied by an audible cracking sound, a brief flash of white light at the target site, and a shock wave which is palpable in the surrounding skin. A typical

wheel and flare reaction follows and the residual erythema fades over 24 hour, and protective shielding of the operator and patient are required. Although transient hyperpigmentation is common, the normal texture of the skin and epidermal markings are retained. The 1064 nm pulse has no significant effect on normal non-tattooed skin.. The Nd/YAG laser pulse at 532nm produces an immediate pure white discoloration and elevation of the skin at the impact site. There is a marked reduction in the auditory component and palpable pressure wave, compared with the 1064nm wavelength. Hypopigmentation occurs commonly at the treatment site, due to the absorption of the 532 nm pulse by epidermal melanocytes.

After laser treatment antibacterial cream was applied, and the patients were advised not to scrub the area, and if a scab should form, it should not be picked, scratched, or removed prematurely.

Results

The age of all patients was ranged from 17-60 years. Amateur tattoos were, in general, acquired at an older age (mean age 33.02 ± 7.9 , range 17-60) than professional tattoos (mean age of 31.12 ± 7.16 , range 19-45 years).

Amateur tattoos were often more numerous than professional tattoos, the patients had two or more tattoos, and one had five tattoos **Table 1**. The majority of tattoos were on the arms 127 (43.3%), forearms 91 (31%), hands 37 (12.6%), Face 17 (5.8%), chest 8 (2.7%) , shoulders 6 (2%), legs 5 (1.7%), and feet 2 (0.6), **Table 2**

Table 3 shows the current status of 239 amateur black tattoos after treatment at 1064 nm. A clinical clearance was defined as a $\geq 75\%$ area clearance of the tattoo. Eighty per cent of tattoos (198 of 239) were clinically clear at the time of analysis. This included 70.7% (169 of 239) which were $\geq 95\%$ clear as shown in **figure 1**. **Figure 2** shows the clearing of a typical amateur tattoo following a one session of treatment.

Table 4 shows the progressive clearing of a typical amateur tattoo following a series of treatments and the cumulative response by the number of treatments, for 136 amateur tattoo patients. The average number of treatments to achieve clinical clearance was two. The higher number of treatments associated with lower percentage clearance in this group suggests that some tattoos are relatively slow responders. Tattoos achieving

less than 50% clearance had received less treatment than the other groups. Overall, 56.6% of amateur tattoos were clinically clear after two treatments, and 82% (110 of 134) were clinically clear after 2-3 treatments.

Table 4 shows the responses of 54 professional black tattoos after treatment. Seventy-four per cent (40 of 54) were clinically clear, including 50% (27 of 54) which were $\geq 95\%$ clear. The progress of a professional tattoo after six treatments is shown in **table 3** and **figure 1**. The cumulative response by number of treatments for 40 professional tattoo patients is shown in **table 4**. Overall, the clinical clearance rate was 40% after six treatments for professional black tattoos. **Figure 2** shows the progressive clearing of a professional tattoo following a third session of treatment.

It is anticipated that response rates will increase when tattoos at an early stage of treatment receive further treatments and the P value was (0.004) which mean that there is significant difference between two groups.

Table (1) Details of 293 tattoos (239 amateur, 54 professional) in 167 patients.

No. of tattoos per patient	Amateur	Professional
1	64	26
2	43	11
3	19	2
4	7	-
5	1	-

No. = number

Table (2) Site involved and number of tattoos.

Site involved	Amateur	Professional	Total
Arms	101	26	127 (43.3%)
Forearms	79	12	91 (31%)
Hands	31	6	37 (12.6%)
Face	12	5	17 (5.8%)
Chest	6	2	8 (2.7%)
Shoulders	5	1	6 (2%)
Legs	3	2	5 (1.7%)
Feet	2	0	2 (0.6%)

Table (3) Current status of 239 amateur and 54 professional tattoos after laser treatment.

Area cleared	Amateur	Professional
≥ 95	168 (70.29%)	27 (50%)
75-95	29 (12.13%)	13 (24.07%)
50-75	17 (7.11%)	12 (22.22%)
25-50	12 (5.02%)	0
0-25	13 (5.43%)	2 (3.7%)

Table (4) Number of laser treatments used for different tattoo types.

No. of sessions	Amateur	Professional
2	77 (56%)	3 (7.5%)
3	33 (24.2%)	4 (10%)
4	14 (10.2%)	6 (15%)
5	2 (1.4%)	10 (25%)
≥ 6	8 (5.8%)	16 (40%)

No. = number

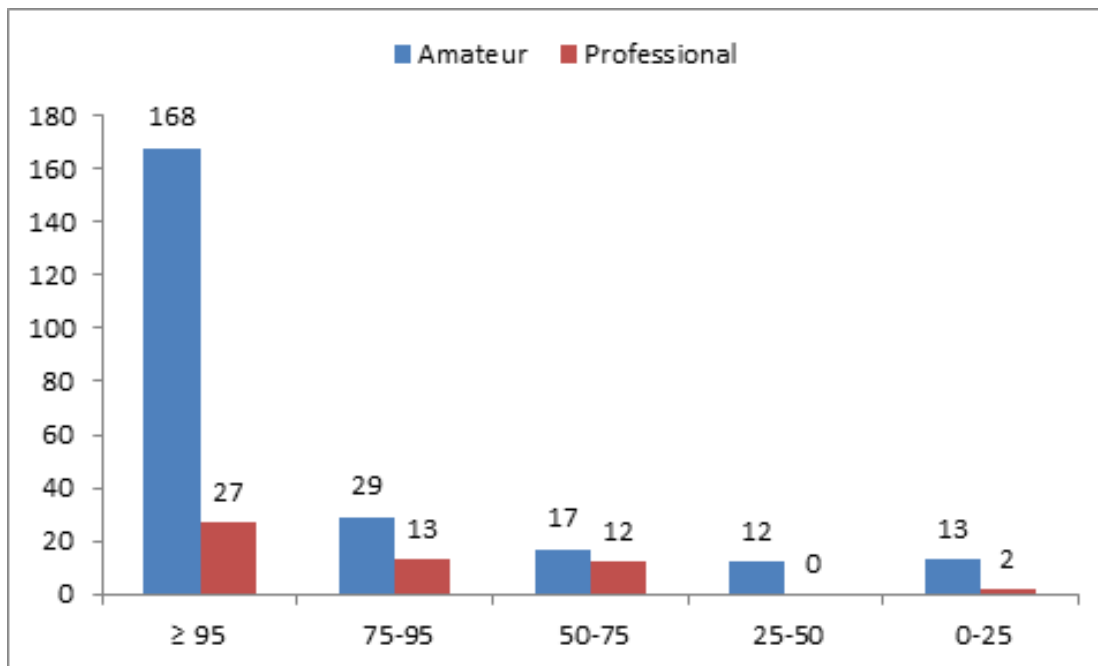


Figure (1) Area cleared of 239 amateur and 54 professional tattoos after laser treatment.

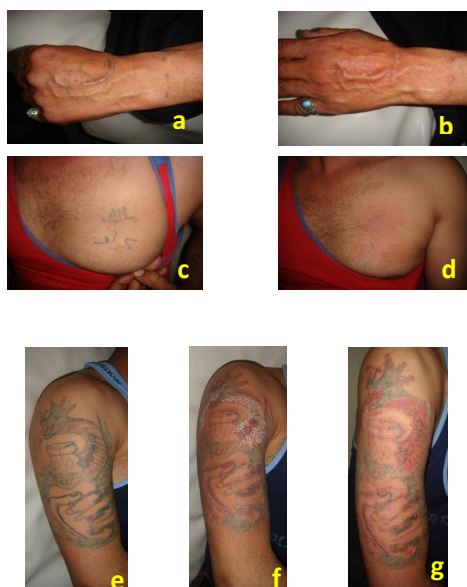


Figure 2 Amateur tattoo on the back of the hand: (a) before treatment: (b) 1 month after the first treatment. And amateur tattoo on the chest: (c) before treatment: (d) 1 month after treatment. Both Show $\geq 95\%$ clearance of tattoo. Professional tattoo on the right arm: (e) before treatment: (f) immediately after first session: and (g) 1 month after the third treatment. Showing slight clearance of black and red tattoo and persistence of green tattoo.

Discussion

Complete laser tattoo removal requires multiple treatment sessions, typically spaced at least 4- 6 weeks apart. At each session, some but not all of the tattoo pigment particles are effectively fragmented, and the body removes the smallest fragments over the course of several weeks. The result is that the tattoo is lightened overtime. [15, 16] Immediately after laser treatment, a slightly elevated, white discoloration with or without the presence of punctuate redness is often observed. This white color change is thought to be the result of rapid, heat-formed steam or gas, causing dermal and epidermal vacuolization. Pinpoint bleeding represents vascular injury from photo acoustic waves created by the laser's interaction with tattoo pigment. [17]

We evaluated in our clinic the efficacy of a laser system providing QS lasers with the wavelengths of 1064 nm and 532 nm treat various types of tattoos. The Nd:YAG laser is an effective treatment for amateur black tattoos and has a low incidence of side effects.

We did not use topical anesthesia in our study because our patients tolerated well to procedure. The energy that selected is 600-800mj because at this range

this energy is enough to cause immediate whitening without punctuate bleeding or immediate blistering to target tattoo lesions at 3 mm spot size. [4,18] And this explains no scar formation i.e. in higher energy density may cause skin damage and subsequently scarring.

Previous study regarding amateur tattoo show that the majority (60%) attain an excellent response after 1 or 2 treatments, but a minority (3.3%) require up to five treatments. Those tattoos with a $< 50\%$ response had received very few treatments. [4]

In our study also show that the majority of patients (82%) attained excellent response in 2-3 sessions, and the minority of patient (5.8%) require more than six sessions in amateur tattoo. While professional tattoo about 40% of patients need more than six sessions, the increasing response with the increasing number of treatments suggests that this group are likely to respond to further treatments.

In other previous study was showed those ten amateur tattoos and two professional tattoos. Of these, amateur tattoos showed an improvement of 69% by GAS and 58% by the PA. In contrast, professional tattoos showed a 40% lightening by GAS scoring and 35% improvement by PA. [19]

Similar finding was seen in our study, an average improvement $\geq 95\%$ in 168(70.29%) patients with amateur tattoos, while response in professional tattoo was 50% (27 patients) .

Amateur tattoos had a quicker clearance rate than professional tattoos. Professional tattoos may require 4-6 sessions more for clearance as compared to amateur tattoos, and this goes with many previous studies. [20-22] Amateur tattoos are less dense with more superficial location of pigment, which is easier to clear. However, few amateur tattoos have deeply placed ink and may be difficult to remove.

In comparison between two group professional and amateur tattoo in response to Nd:YAG laser the P value was (0.004), which means that there is a significant difference between two groups .

Conclusion

The Q switched Nd/YAG laser is an effective treatment for both black and red tattoos with a low incidence of significant adverse effects and provides excellent cosmetic results. Amateur tattoos generally

require fewer treatment sessions and the response is better than professional tattoos.

Ethical Clearance: The Research Ethical Committee at scientific research by ethical approval of both environmental and health and higher education and scientific research ministries in Iraq

Conflict of Interest: The authors declare that they have no conflict of interest.

Funding: Self-funding

References

- Choudhary S, Elsaie ML, Leiva A, Nouri K. Lasers for tattoo removal: a review. *Lasers Med Sci* 2010; 25:619.
- Naga LI, Alster TS. Laser Tattoo Removal: An Update. *American journal of clinical dermatology*. 2017;18(1):59-65.
- Ortiz AE, Alster TS. Rising concern over cosmetic tattoos. *Dermatol Surg*. 2012;38:424-9.
- Athir M. AL Saad , Abd Alkhaliq S. Abdullah. Tattoo Removal using (1064 nm and 532 nm) Q-Switched Nd: YAG Laser. *JFac Med Baghdad* 2017; Vol.59, No .3
- Kent KM, Graber EM. Laser tattoo removal: a review. *Dermatol Surg*. 2012;38:1-13.
- Anderson RR, Parrish JA. Selective photothermolysis: precise microsurgery by selective absorption of pulsed radiation. *Science*.1983;220:524-7.
- Kunachak S, Kunacharkr S, Sirikulchayanonta V, Leelaudomniti P. Dermabrasion is an effective treatment for acquired bilateral nevus of Ota-like macules. *Dermatol Surg* 1996;22:559-562.
- Geronemus RG. Fractional photothermolysis: Current and future applications. *Lasers Surg Med* 2006;38(3):169-176.
- Anderson RR, Margolis RJ, Watanabe S, Flotte T, Hruza GJ, Dover JS. Selective photothermolysis of cutaneous pigmentation by Q-switched Nd:YAG laser pulses at 1064, 532, and 355 nm. *J Invest Dermatol* 1989;93(1):28-32.
- Levin MK, Ng Elise, Bae YSC, MD, Brauer JA, and Geronemus RG. Treatment of Pigmentary Disorders in Patients With Skin of Color With a Novel 755 nm Picosecond, Q-switched Ruby, and Q-switched Nd:YAG Nanosecond Lasers: A Retrospective Photographic Review. *Lasers in Surgery and Medicine* 48:181-187 (2016).
- Kilmer SL, Farinelli WF, Tearney G, Anderson RR. Use of a larger spot size for the treatment of tattoos increases clinical efficacy and decreases potential side effects. *Lasers Surg Med* 1994; (6):51. Suppl.
- FERGUSON JE, AUGUST PJ. Evaluation of the Nd:YAG laser for treatment of amateur and professional tattoos. *British journal of Dermatology* 1996; 135: 586-591.
- Schneibner A, Kenny G, White W *et al*. A superior method of tattoo removal using the Q-switched ruby laser. *J Dermatol Surg Oncol* 1990; 16; 1091-8.
- Lanigan SW. Acquired port wine stains: clinical and psychological assessment and response to pulsed dye laser therapy. *Br J Dermatol* 1997; 137: 86-90.
- Kirby, William, Desai, Alpesh, Desai, Tejas, Kartona, Francisa, Patel, Getta The Kirby-Desai Scale: A Proposed Scale to Assess Tattoo-removal Treatments, *Journal of Clinical and Aesthetic Dermatology*, March 2009, Volume 2, No. 3 .
- Fatima A. Mohammad Ali, Ali S. Mahmood; HDipLM/surgery. *IRAQI J MED SCI*, 2009; VOL.7 (3):66-81
- Kirby, William, Desai, Alpesh, Desai, Tejas, Kartona, Francisa, Tattoo Removal Techniques: Effective Tattoo Removal Treatments - Part 2, *Skin and Aging*, October, 2005 .
- Kilmer SL, Farinelli WF, Tearney G, Anderson RR. Use of a larger spot size for the treatment of tattoos increases clinical efficacy and decreases potential side effects. *Lasers Surg Med* 1994; (suppl 6):51.
- Chemboli Lakshmi, Gisayathri Krishnaswamy. Efficacy of the q-switched neodymium: Yttrium aluminum garnet laser in the treatment of blue-black amateur and professional tattoos. *Indian journal of dermatology* 2015;60(6);578-583.
- Reid R, Muller S: Tattoo removal by CO2 laser dermabrasion. *Plast Reconstr Surg*. (1980).Jun; 65(6): 717-28.
- Reid, WH, Miller, ID, Murphy, MJ, Paul, JP, Evans, JH: Q-switched ruby laser treatment of tattoos, a 9-year experience. *Br. J. Plast. Surg*. (1990). 43:663-669.
- Stratigos AJ, Alora MB, Urioste S: Cutaneous laser surgery. *Curr Probl Dermatol* (1998). 10:127-74.