



TREATMENT OF BLACK TATTOO BY 1064NM Q-SWITCHED ND: YAG LASER

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ABSTRACT

From the beginning of humanity, tattooing has existed as well as the desire to remove them. After years of methods leaving scars, came the era of lasers. Using of quality-switched (Q-switched) laser systems have been available, which leave minimal damage. They are able to remove some tattoos, depending on pigments used, without scarring, hypopigmentation or hyperpigmentation. The experiment was done to evaluate 1064nm Q-switched Nd:YAG laser for removing black tattoo. This open therapeutic trial was done in Beirut Centre of Dermatology in Baghdad. Thirty nine persons (31 men and 8 women) with black tattoo on different parts of body (hand, face and chest) were included in this study. Ages were between 19-50 years with mean of 25.25 ± 3.78 SD. Patients were divided according to the type of tattoo into amateur and professional tattoos; fifteen patients had amateur tattoo while, twenty four patients with professional tattoo. A Q-switched Nd:YAG laser deliver $1000\text{m}/\text{cm}^2$ pulses at wave length of 1064 nm with pulse duration of 7-10 ns and exposure spot size of 1mm with repeat frequency 2- 5HZ. Five sessions were done. At the end of fifth session, excellent response was seen in 16 patients (66.6%) of total 24 professional black tattoo and good response (51-75%) was seen in 6 patients (25%). In amateur black tattoo; at the end of fifth session, excellent response was seen in 10 patients (66.6%) of total 15 amateur black tattoo and good response was seen in 5 patients (33.3%). No scarring and no permanent complication was registered. Q-switched Nd:YAG laser could be a safe and an effective for black tattoo removal.

KEYWORD: Tattoo|Q-switched Nd:YAG laser fluency.

INTRODUCTION

Tattooing is the practice of producing an indelible mark or figure on the human body by inserting a pigment under the skin using needles or other sharp instruments which results in permanent designs or inscriptions.⁽¹⁾ In practice, different types of tattoo exists according to either the process (amateur, professional, cosmetic, medical, and traumatic (natural).⁽²⁾ or the colour of tattoo depending on its components. Because of its permanent character and great difficulties associated with the attempts to remove it; no ideal method of tattoo removal exists.⁽³⁾ Techniques, which can be employed to remove artistic tattoos include: total surgical removal, dermabrasion, salabrasion, cryosurgery and laser therapy.^(4,5,6) In the present, it is believed, that laser therapy is the best in cosmetic terms method of tattoos removal.⁽⁷⁾ Lasers employed include so called **Quality switched lasers (QS)**: Yttrium: Aluminium danel (YAG, 532 nm) 1341, rubin (694 nm), Nd:YAG (532 nm, 1064 nm) and alexandrite (755 nm).⁽⁷⁾ Localisation, age & type of the skin undergoing procedure,⁽⁷⁾ in addition to specification of the type of pigment used would determine the type of laser used for tattoo removal.

For removal of tattoos containing black, blue and green pigment QS ruby laser and alexandrite laser are recommended,^(7,8) Nd:YAG laser (QS - 532 nm) removes red hint tattoos,⁽⁷⁾ whereas Nd:YAG laser (QS - 1064 nm) is preferable in the black and blue pigments.^(7,9) Lasers emitting green light (510 nm pulsed dye laser and 532 nm

frequency doubled laser Nd: YAG) enable successful removal of red pigment.⁽¹⁰⁾

Laser removal of tattoos is unfortunately not devoid of side effects. Complications arising after such procedures include the following: Scarring,^(10,11) pigment abnormalities in the form of hypo and hyperpigmentations,^(12,11,7,13) lack of ability to totally erase the tattoos,⁽¹¹⁾ infection^(11,7) bleeding, change of tattoo colour, even its intensification,⁽¹¹⁾ ecchymoses, oedema and blisters can also appear.⁽¹⁰⁾ To a lesser extent, allergic reactions can occur especially following procedures applying ruby QS and Nd:YAG lasers.⁽⁷⁾ The aim of the present work is to evaluate the efficacy and safety of Q-switched Nd:YAG 1064 nm as a laser modality for the removal of black tattoo.

MATERIAL AND METHODS

This is an open therapeutic trial performed in Beirut Dermatological Center in Baghdad, in the period between July 2008- October 2010. All patients had black tattoo on different parts of body (hand, face and chest). A written consent was taken from each patient participating in this study & the study protocol was approved by ethical committee in Al- Kindy Teaching Hospital.

Thirty nine patients (31 men and 8 women) were included in this study.

Their ages ranged between 19-50 years with a mean of 25.25 ± 3.78 SD.

Fifteen patients had amateur tattoo while 24 patients had professional tattoo.

Pregnant or lactating women were excluded from the study.

Digital photographs were taken before each treatment. Treatment sessions were planned to be done every 2 weeks interval for 5 sessions.

Clearing of tattoo was scored by two independent investigators familiar with treatment of tattoos and the grading of tattoo ink lightening by photographs assessments.

The percent of clearing of tattoo was scored depending on the basis of quartile rating scales as (poor response=0-25%, fair =26-50%, good=51-75% and excellent=76-100%).

Follow up of patients were observed for 3-6 months after last session to assessment of clearing tattoo and any possible side effect.

Q-switched Nd:YAG laser (Quanta electronics Co. , LTD) was used to deliver 1J/cm² pulses at wavelength of 1064nm with pulse duration of 7-10 nanosecond and exposure spot size of 1mm with repeat frequency 2-5HZ.

Local anesthesia used was EMLA cream (Lipricaine cream) was applied 30min.-1hours before sessions.

Wound care consisted of using local antibiotics (fucidic acid oint.) and Sunscreen cream.

Statistical analysis

All data were coded and entered by using Microsoft Excel 2010 and epi_info

Version 6 .Comparison between all groups was done by using analysis of variance. Comparison before and after treatment in each group was done by using t-test and p-value < 0.05 was considered as level of significance.

RESULTS

All patients had black tattoo: 15 with amateur tattoo and 24 with professional one.

Patients with amateur black tattoo

As shown in table (1), after 1st session of treatment, the result was as the following: fair response(26-50%) was seen in 13 patients(86.7%) and poor response (0-25%) was seen in 2 patient (13.33%) of total 15 patient with amateur black tattoo. At the end of fifth session an excellent response (76-100%) was seen in 10(66.67%) and good response (51-75%)was seen in 5 patient (33.33%).table(1, 2) and figure (1).

TABLE1: Response of patients with amateur black tattoo after treatment sessions with Q-switched Nd : YAG laser.

Sessions	Poor response (0-25%)	Fair response (26-50%)	Good response (51-75%)	Excellent response (76-100%)	Total
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
1 st (2 wks)	2(13.33)	13(86.7)	0(0)	0(0)	15(100)
2 nd (4 wks)	1(6.67)	9(60)	4(26.6)	1(6.67)	15(100)
3 rd (6 wks)	0(0)	3(20)	7(46.67)	5(33.33)	15(100)
4 th (8 wks)	0(0)	1(6.67)	6(40)	8(53.33)	15(100)
5 th (10 wks)	0(0)	0(0)	5(33.33)	10(66.67)	15(100)

TABLE 2: Response of individual patients with amateur black tattoo after each treatment session.

Patient NO.ID	Percentage of Improvement%				
	2wk	4wk	6wk	8wk	10wk
1	10	25	50	47.5	55
2	15	30	45	60	66
3	40	45	45	70	75
4	40	45	60	72.5	60
5	40	40	65	74	67.5
6	45	50	60	75	80
7	35	50	65	57.5	95
8	30	49	67.5	90	90
9	26	47	68	95	92
10	46	35	72.5	92.5	85
11	48	33	80	82	80
12	44	34	90	86	97
13	50	38	95	87.5	90
14	49	40	97.5	79	88
15	49	50	98	77.5	98
Mean	37.8	40.73	70.56	76.4	81.23
SD	12.46	08.06	18.08	13.54	13.75
Variance	155.45	65.06	326.92	183.57	189.31
T-test	-----	0.451719077	5.16651E-06	8.11288E-09	8.87
P-Value	-----	0.451719077	<0.00001	<0.00000	<0.00001

TABLE 3: Response of patients with professional black tattoo after treatment sessions with Q-switched Nd:YAG laser

Sessions	Poor response (0-25%)	Fair response (26-50%)	Good response (51-75%)	Excellent response (76-100%)	Total
	No. (%)	No. (%)	No. (%)	No. (%)	
1 st (2 wks)	4(16.66)	20(83.33)	0(0)	0(0)	24(100)
2 nd (4 wks)	1(4.16)	13(54.16)	10(41.66)	0(0)	24(100)
3 rd (6 wks)	0 (0)	6 (25)	14(58.33)	4(16.66)	24(100)
4 th (8 wks)	0 (0)	3(12.5)	8(33.33)	13(54.16)	24(100)
5 th (10 wks)	0 (0)	2 (8.33)	6(25)	16(66.67)	24(100)

TABLE 4: Response of individual patients with professional black tattoo after each treatment session

Patient NO.ID	Percentage of Improvement%				
	2wk	4wk	6wk	8wk	10wk
1	20	23	26	57	37.5
2	15	28	50	70	55
3	13	50	38	73	52
4	24	45	45	75	67
5	45	40	42	55	68
6	40	36	47	71	70
7	36	39	41	70	55
8	39	35	70	36	90
9	41	38	72.5	71	86
10	45	35	61	78	80
11	47.5	33	67	90	82
12	49	34	75	91	78
13	36.5	38	52	77	76
14	38	40	73	47	90
15	50	75	98	78	88
16	45	72.5	90.5	83	91
17	50	65	78	89	90
18	40	55	79	86	87.5
19	42.5	58	66	90	86
20	42	67	60	91.5	90
Mean	38.54	48.48	62.54	74.92	77.40
SD	10.41	15.82	17.34	14.19	15.21
Variance	108.38	250.336503	300.8460145	201.3623188	231.43
T-test	-----	0.014	1.06176E-06	7.32541E-13	6.25319E-13
P-Value	-----	<0.0140096	<0.00001	<0.00001	<0.00001

In the same patient's group with amateur tattoo, the improvement after 2nd treatment session failed to reach a significant level however, soon after that from 3rd session and onward, the improvement was starting to be highly significant as the P-value was(<0.00001) table (2).

Patients with professional black tattoo:

The response of patients with professional tattoo after 1 treatment session revealed a fair response in 20 patients (83.33%) of total 24 professional black tattoo and poor response in the rest four patients (16.67%). At the end of fifth session, excellent response was seen in 16 patients (66.66%) of total 24 professional black tattoo and good response were seen in other six (25%), while two patients(8.33%) were obtained a fair response table(3). In this group, the percentage of tattoo removal reach a significant level after 3rd treatment session when it is been highly significant (P-value < 0.00001) as mentioned in table (4).

Side effects

There were no significant side effects observed in the patients throughout the treatment. Immediately after treatment, the area turns gray, then, white reaction quickly follows. Although local anesthesia was used for the treatment site in all patients, most of them complained some degree of pain but the more rapid delivery rate did accentuate the pain for some patients.

Once pulse delivery was completed, the treated area was not painful and most patients noted that subsequent treatments were less painful, coinciding with decrease clinically apparent ink. Transient textural change was seen in two patients (5.1%) of 39 tattoos, these changes cleared with time. Hypopigmentation was seen in single tattoo lesion (2.5%) of 39 tattoos, this hypopigmentation was mild and resolved within two months. Mild blister was seen in one patient (2.5%) of the total group. Mild pinpoint bleeding was seen in single (2.5%) tattoo and resolved within 7 days.

DISCUSSION

As tattooing becomes increasingly popular, the need for tattoo removal will also increase. Despite the improvement in tattoo-clearing laser therapy, more efforts are required to optimize the efficiency of treatments and simplicity of procedures to decrease the number of sessions and reduce the adverse effects. The 1064nm Q-switched Nd:YAG laser was used in our study to remove black tattoo. In our study demonstrate that, an excellent response (>75% ink removal) was seen in 10 (66.66%) of 15 Amateur tattoos at 1j/cm and good response (51-75%) in 5(33.33%) after fifth sessions. An excellent response was seen in 16 (66.66%) of 24 professional black tattoos and good response in 6(25%) after fifth sessions at 1j/cm. Fair response (26%-50%) was seen in 2(8.33%) of 24 professional black tattoo. These results compared to the previous a study which was done by Kilmer et al.⁽¹⁴⁾; 1064nm Q-switched Nd:YAG laser was used to deliver 10-12j/cm pulses with spacing 3-4 weeks interval. On the other hand, our study we used fluence of 1j/cm and spacing between sessions of 2 weeks only.

The study which was done by Kilmer *et al.* demonstrated that an excellent response (>75% ink removal) was seen in 77% of black tattoos and more than 95% of the black ink cleared in 11(28%) of 39 tattoos at 10 to 12j/cm after four treatment sessions. Similarly in our study: tattoos were an excellent clearing was observed in 66.66% in both amateur and professional tattoo. Although both results were comparable, the minor difference between the results can be explained by the great difference in the fluence used as Kilmer et al study used 10-12j/cm. The side effect: the study of Kilmer et al, 2 (5.1%) of 39 patients treated with QSYAG laser had trace transient textural changes during the 4 weeks healing period. No hypopigmentation or scarring occurred in treated tattoos. Three patients (7.6%) (darker skin type 11 through 1V) experienced hypopigmentation.

In our study; two patients (5.1%) had trace transient textural changes resolved after one month. one patient (2.5%) has hypopigmentation which resolved after two months from last session. No hyperpigmentation was seen. These results are comparable to the study of Kilmer et al.

In general, the side effect in both studies showed only minor, tolerable and transient side effect. In Kilmer's study, all the patients were light skin while most of our patients were darkly pigmented. This difference may explain the hyperpigmentation seen in Kilmer's study and hypopigmentation that was observed in our study.

Pigmentary changes are partially a wave-length dependent phenomenon. At the 1064 nm wavelength laser appears to exert its effect at a dermal level, often leaving the overlying epidermal melanocytes intact.⁽⁶⁾ this hypopigmentation was seen during the multiple treatments. The lack of scarring noted with Q-switched lasers, even when epidermal damage is noted, is most likely due to the lack of thermal injury to collagen due to highly selective effect on tattoo pigment in intracellular or extracellular compartments.⁽¹⁵⁾ Pin-point bleeding: occurred in one case this is due to in direct vascular Injury from photo acoustic waves generated by the laser interaction with tattoo pigment.⁽¹⁶⁾ The pin-point bleeding was resolved after 5 days; it was treated by cleaning the area and topically applying antibiotic ointment to prevent

secondary infection. Blisters occurred in one case and resolved after three days. It was treated by antiseptic to prevent infection. No hyperpigmentation or allergic reaction was seen in this study. These results compared to other treatment remedies as illustrated below: The newest researches of Prinz et al.⁽¹⁷⁾ in a group of 76 people undergoing tattoo removal procedure employing the following lasers: Nd:YAG (QS - 532 nm and 1040 nm). Alexandrite laser (QS - 755 nm) and Nd:YAG laser with variable impulse, confirm the effectiveness of the above mentioned methods. Complete removal of tattoos was noted in 14 patients (19%) in whom bleaching of the tattoos of more than 95% was achieved⁽¹⁸⁾. In this group the best results following laserotherapy procedures were achieved in cases of professional tattoos of black-blue colour tint.

Alexandrite laser (QS - 755 nm, 100 ns) was used in cases of professional tattoos: their total removal was achieved following average of 8.5 expositions similar results were presented by Fitzpatrick and Goldman⁽⁸⁾.

Total removal of tattoos was noted on average after 8, 9 sessions, following employment of alexandrite laser with similar characteristics⁽⁸⁾. Troilius's observations⁽¹⁸⁾ suggest considerable effectiveness of YAG:Nd laser (QS - 1064 nm) in cases of posttraumatic tattoos removal, with their total erasure after 2-5 expositions. Ashi-noff et al. noted total removal of the tattoo following 1 -6 procedures applying QS ruby laser.

Graundenz et al.⁽¹⁹⁾ applied QS lasers: rubin (694 nm) and YAG:Nd(1064 nm), obtaining 80% reduction of the pigmentation within a tattoo and not experiencing any complications in the form of abnormal pigmentation, scarring or darkening, so called "ink darkening".

Alexandrite QS laser employment is associated with changes of skin structure in 12% and transient hypopigmentation in 50%.⁽⁷⁾ Observations of Fitzpatrick et al.⁽⁸⁾ include complications such as transient hypopigmentation reported in approximately 50% people undergoing discussed procedures. According to Kuperman et al.⁽⁷⁾ skin texture changes and hypopigmentation are among the rare complications following application of QS YAG: Nd laser. Lapidotli *et al.*⁽²⁰⁾ reported that hyperpigmentation resulting from tattoo removal with QS YAG:Nd or rubin laser receded after approximately 2-4 months and was noted in 44% of treated subjects, so it is considered safe and effective treatment for use 1064-nm QS:YAG laser in black tattoo. Therefore, tattoo removal should match the absorption spectra of the tattoo pigment, which leading to minimal percentage of reflection of irradiation wavelengths from the pigment was obtained and also decrease number of pulses with low fluencies, adverse effects and morphologic with pigmentation effects were minimized. The effectiveness of the clearing process did not improve by delivering more fluence, increasing the number of pulses or using higher repetition rate without match the laser wavelength with absorption range of ink may lead to excessive scarring while leaving much of the tattoo pigment behind. However, all patients reported a preference for the Q-switched Nd:YAG Laser, because of the shorter treatment time, less post-operative pain and shorter healing time. Once pulse delivery was complete, the treated area was not painful. Most patients noted that

subsequent treatments were less painful. In conclusion 1064nm Q-switched Nd:YAG laser is an effective and safe

treatment applied for black tattoo with a short duration , low fluence and less side effect



FIGURE 1 : 29 years old male with Amateur black tattoo before treatment and after 3rd treatment session

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