SHORT REPORT

Fast tattoo removal using Q-Switching ND-YAG laser technique with multi pass sessions

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Abstract

Laser therapy is the gold standard method to remove unwanted tattoos. It is available and widely accessible. This study was done to assess the efficacy of the R20 method (multi-time separated passes in one session for 20 min) using Q-switched ND: YAG laser for the removal of tattoos and was compared with the traditional method. Forty patients with 40 Tattoos were included. These tattoos were separated into two halves left and right. One half was treated with a single pass and the other half with R20. Both halves were treated using Q-switched ND-YAG laser with 10 J/cm^2, 1.064 µm, 8 ns pulse width, and 3 mm spot size. The treatment regimen included three sessions at three-week intervals. Tattoo bleaching was evaluated in each session by means of using the imaging process by two dermatologists. It could be concluded that the treatment with traditional single-pass is less effective than the R20 method in the three-month period. Epidermal healing period needs more than three weeks with the R20 method. The amateur tattoos have a significantly better response than professional tattoos. The R20 method is better than the traditional method to remove a tattoo, where most tattoos can be removed in one session. Amateur tattoo is removed faster compared to professional tattoo using R20 method because amateur tattoo affects the skin surface.

Keywords: SPSS, multi passes, tattoo removal, Q-switched ND-YAG laser.

Introduction

A tattoo refers to the implantation of an exogenous pigment within the skin or mucous membranes.[1] Tattoos were a part of human lifestyle for hundreds of years. It represents an extensive variety of patterns and symbolic values. Nowadays, millions of people have or are planning to have tattoos because they consider it as a fashion style. However, many tattoo customers regret their tattoo sooner or later. This resulted in the development of powerful and safe methods for tattoo removal in the medical community.[1,2]

The medical laser applications are considered one of the solutions to remove tattoos. This can be explained as an interaction between the laser beam and tissue. Physicians or surgeons should be aware of laser-tissue interaction complications. This can be made safe by selecting optimal laser systems and modifying the type of therapy.[3-5] The ND: YAG laser (QS 1.064 µm) is widely used in cosmetic laser dermatology for pigmented and vascular lesions, removal of tattoos, and unwanted hair. The preferable and efficacious wavelength used in the treatment is 1.064 µm. The penetration depth of the laser wavelength and scattering ensure a good homogeneous distribution of treatment irradiation.[6]

This laser wavelength is transmitted through pores of the skin, where it is absorbed by blue, green, or black tattoo pigments. The repetition rate of the laser beam (about 100 ns) destroys ink debris quickly by maximum giant heating of dermal tissue. Another type of laser, namely Q-Switching, generates high-power pulses used to treat unwanted tattoos on the basis of selective photothermolysis principles.[7]

Laser treatment sessions achieve suitable whitening tattoo in 4-6 sessions for amateurs and 20 sessions for professional. Each consecutive treatment with a period of 1-2 months between the sessions, removes some of the remaining colours. The number of therapy sessions depends on the colour, shape, density, depth, length, location of the body and form of tattoo inks[7,8] Sometimes tattoo ink spots remain after laser treatment, which clear later or are rephagocytosed into smaller accumulations. They gradually reduce in size and are no longer visible. Treatment sessions are often long, expensive, and sometimes impracticable that cause dissatisfaction to the patient. Moreover, treatment risks include permanent hypopigmentation, scarring, and the probability of only partial removal of tattoos.[8] A wide variety of treatments resulted in different results of tattoo elimination. Multi-time laser exposure is found to be more effective in the immediate whitening reaction than a single laser exposure.[9] Immediate whitening is a normal response to QS laser therapy due to bubbles within the epidermis. The immediate whitening response fades over approximately

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20 minutes because the gas bubbles dissolve within this time period. The cumulative effect of two successive pulses appears to offer slightly better results.[10,11] The two pulses of treatment parted by 30 seconds to 20 minutes were not more effective than one pulse.[12-14]

A large number of treatment sessions provided the tattoo with large quantities of ink, obtained by filling. The result in tattoo clearing can only be measured after completion of the procedure, which can take 2-3 years in some cases. In certain cases, full clearance is probably unlikely.[15] In this study, we compared the effectiveness of QS laser tattoo removal in one pass versus multi-time treatment among forty patients. The time between two sequenced sessions was 20-minutes. Many variable response rates are considered with tattoo removal treatments. Different coloured tattoos were studied with patients of varying ages and gender. The tattoos were of different types being amateur or professional having a different size and location on the patient's body.

Subjects and Methods

This research on humans was performed according to the principles of Iraqi institutional ethical scrutiny. This study involved forty cases health volunteers treated by 20 professionals and 20 amateur tattoos with pre-approval guarantee. Pregnant patients were excluded. All these cases were recruited through posters in tattoo parlours after providing informed consent. The location of the tattoo was variable, and size ranged from 1.5 to 2.5 cm^2. Amateur tattoos were black and green, with red pigment and two small areas of blue pigment comprising the number of professional tattoos. A number of amateur tattoos had extra pigment. Amateur tattoos previously subjected to skin withdrawal, showed increased pigmentation. Tattoo images were compared before and after laser irradiation. Mean and standard deviation values were extracted using designed programme in Matlab software for all images. Each variable value for image represents the average of three images taken of the same measurements.

Treatment and procedure: EMLA anaesthesia Cream (AstraZeneca AB, Sweden) was applied 30 minutes before treatment. After laser treatment, the ointment bepanthen was applied in case of severe erythema and if the patient needed it. After treatment the cleaning was done twice daily and sunlight was avoided. The patients were regularly attending the clinic for a period of three months. They were asked to complete a questionnaire about the degree of whitening of tattooing and their satisfaction. All tattoos were treated using a QS ND-YAG laser with the wavelength of 1.064 μm, the regular beam diameter of 3-5mm, a hundred nanosecond pulse period and fluorescent 10 joules/cm^2 delivered at 1 Hz. The laser hand piece was oriented perpendicularly to the skin at all times at a distance of 1-2 cm. A grip of 2-6 mm was used depending on the type and size of the tattoo. Each tattoo was divided into approximately the same area and randomly selected for treatment using either traditional method with a single laser skip or R20 method with three consecutive, 20-minute, separate passes.

In practical terms, the only downside may be reduced by sharing time in the laser therapy room among many patients, because it appeared to be the longest time needed for a therapy session. With twenty-minute intervals with anaesthesia time, the R20 procedure adds at least one hour to the entire time.

Evaluation of response: All cases were recorded by taking images before, after immediate, and 3 months after treatment. These images were analyzed with designed algorithms in Matlab software to extract the computational criteria like mean and standard deviation (SD). The values of mean and STD were compared by two dermatologists and we came up with a new classification to analyze the category of the performance of the treatment. This category was divided into 4 sections depending on the percentage of the mean and STD with dermatologists. Fist group range 0-25% had the mean and STD values shown in Table (1-B), the second group range 26-50%, the third group ranged 51-75%, and finally the fourth group ranged 76-100%. The SPSS software used was with second order built-in function to extract the statistically significant P-value. This P-value describes the changed level in the treatment and is considered a standard value.

Table-1: (A, B) Patient demographics and statistical of R20 and traditional method.

(A): Patient demographics for 40 cases.

Age group	No. of patients	No. of patients with professional tattoos	No. of patients with amateur tattoos
15-24	20	12	8
25-34	12	4	8
35-44	7	4	3
45-54	1	0	1
55-	0	0	0

(B): Statistical data of R20 method and the traditional method.

Type of tattoo	R20 method		Traditional method	
	Mean	STD	Mean	STD
Professional (N= 20)	85	15	15	16
Amateur (N= 20)	88	15	35	18

Results and Discussion

Forty patients, 33 males and 7 females were included in the study. Their ages ranged between 15 and 54 years with majority having Type IV skin colour. The treatment time was 70 to 80 minutes with a gap of 20 minutes between two sessions. The tattoos were black, blue or green. Some patients complained of minor pain and some asked for a local anaesthetic, as a dark skin or with excessive tattoo pigment, there can be greater discomfort. The pain at a later stage was similar in all patients. The tattoo was divided into two sections, a left and right with the former receiving a single pulse and the latter had multiple pulses. Figure-1-C shows the effect of the first immediate laser exposure resulting in light bleaching with inflated skin. Figure-1-D shows the same skin after three sessions of high bleaching. During the session, there was no gross bleeding, tearing of the tissue or loss of dermis. However, there were small blisters, punctate, purpuric rash, and transient inflammation. A scale-crust formed with two halves which sloughed within two weeks. The residual tattoo progressively reduced over 3 to 6 weeks.

Figure-1-D shows the same patient after three sessions with the repeated passes and strong bleaching.

The R20 method can be compared in accuracy with the traditional method. Most (62%) of the tattoo sites were completely cleared with the R20 process. Thirteen of the twenty (65%) professional tattoos, and seventeen of the twenty (85%) amateur tattoos cleared on the half side of

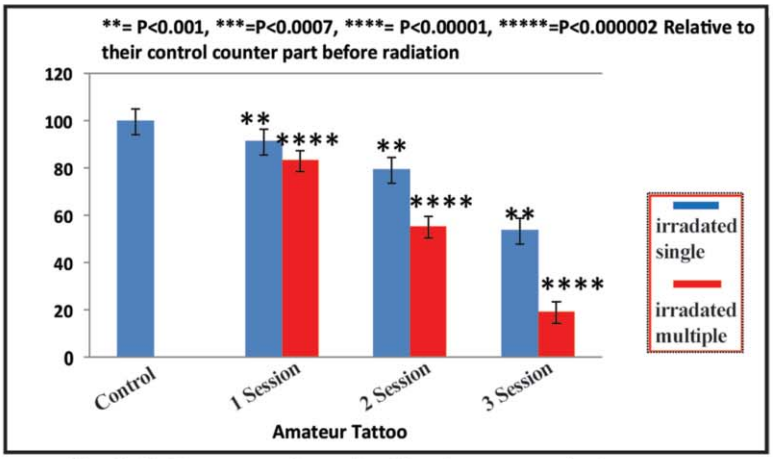

Fig. (1-A): Percentage change in whitening response in the amateur tattoos with single pass method and multiple passes method.

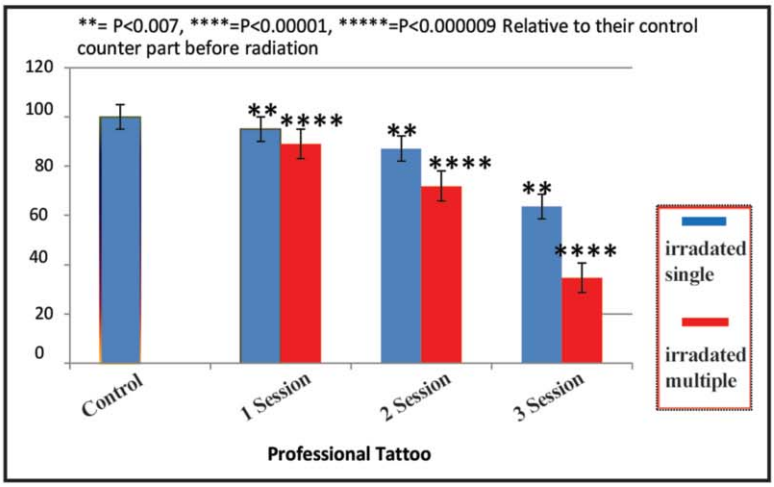

Fig. (1-B): Percentage change in whitening response in the professional tattoos with single pass method and multiple passes method

Fig. (1-C): A patient (39 years) has an amateur tattoo for twenty-four years on the left deltoid skin, type III (A) after the first immediate laser exposure a bleaching appears and (B) after 3 sessions laser exposure.

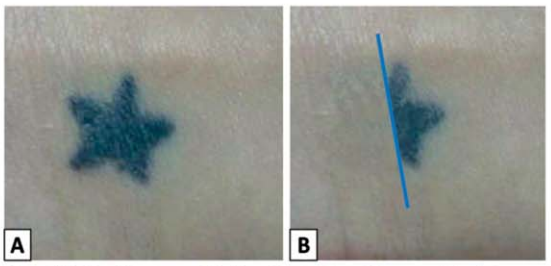

Fig. (1-D): 20-year-old female patient has a third-type skin color, an professional -type tattoo on the lower arm (wrist), with a period of 4 years (A) before treatment. The tattoo is divided into two parts. The left side we use the multi-pass method and the right side the one-pass method (B) After the fifth session is removed. The tattoo is on the left side, while the right-hand side is still present, the energy used was 10 joules/centimeter square at a repetition of 2 beats per second

Figure-1: (A, B) Illustrate the significant differences in the whitening as the function of sessions number of irradiation. The difference between the original and irradiated samples is evaluated by using P-value. This value considered large if it is 0.05. The difference in each laser session equal P = 0.00002 with professional tattoo and P = 0.00001 by amateur tattoo in R20 method.

the tattoo with the R20 method. Average evaluation of lightening, evaluated by imaging process criterion for a professional tattoo treated with R20 method was 83%. While, for an amateur tattoo it was 88%, and later reached to 90% because it had effect on the surface and the tattoo with time becomes lighter (Table-1-B).

Table (1-A) illustrates the patients' details examined within this study. The patients were a mixture of males and females with skin type II, III, and IV. Many patients had both professional and amateur tattoos and were treated with the same technique. Table (1-B) shows the statistical results from the designed algorithm in Matlab software. The laser dose has 10 J/cm^2 at 1.046 µm wavelength in Q-switching technique. The statistical data shows the big difference between the two methods. The mean value is high, that means the bleaching is high, and the value of the skin colour is uniform and has the same value as the skin level. For clarity, the data presented in the Table (1-B) are the average of three photos.

The R20 technique showed a better result compared to the traditional method. Tattoo removal (bleaching), depending on the statistical and dermatologists data, increased by 15% for professional and 35% for amateur tattoos because the amateur tattoo has a surface effect. The results were analysed by the software SPSS version 21. The whitening response was significantly more effective for amateur tattoos as seen in Figure-2 and 3, $P < 0.00001$ the whitening respond with 80% for amateur and 65% for professional ($P < 0.00001$) for the amateur tattoo, and ($P < 0.00002$) for the professional tattoo. In all cases, there were no scars, textural changes, infection, or post-inflammatory hyperpigmentation or hypopigmentation.

Figure-1-E shows a patient with professional tattoo and skin type II on his upper chest for the last one year. Figure-1-F has two parts showing the difference between the three sessions with one pass (on the left) and multi-pass (on right). The difference in results between the single pass and the multi-pass process can be observed.

The treatment plan for appropriate tattoo removal is often long-lasting and costly, as it requires several sessions over a long period of time, and results are often inconsistent, contributing to patient frustration. As a result, the R20 technology was developed to shorten the duration of treatment with several QS laser passes by about 20 minutes in one laser session.[8,16] This technique has been highly successful because this method R20 removes most tattoos entirely or almost entirely during a single treatment session. Our study clearly shows that the multi-time passes of the R 20 laser is the most effective tattoo treatment than conventional laser treatment for both amateur and professional tattoos. On the other hand, the changes in the tattoo pigment have a deeper skin depth than the traditional single pass laser, showing that the multi-pass method did not cause more side effects despite the increase in purpura. Similar findings were previously recorded where QS alexandrite laser (755 nm, 5.5 J / cm^2) was used, and the other half provided 4 passes of treatment with 20 minutes interval between passes.[8]

The mechanism of the R20 method is accurate and more effective as the action on the tattoo ink in the deep dermis is stronger. It is assumed that the multi-pass technique opens the portal to the next pass by removing the effect of the upper skin blocking the laser wavelength. Laser bleaching occurs instantly, and this causes an apparent formation of a gas bubble. In the first pass, the gas bubble limits the penetration of the light laser into the deep dermis. In the second pass, after 20 minutes, the surface gas bubbles are resolved so that the subsequent pulse can penetrate deeper and give more bleaching.[17,18]

Therefore, the anatomical depth of the tattoo can theoretically be closely associated with the number of passes required to remove this specific tattoo during the R20 phase. Moreover, the results of this study also show that amateur tattoos require less treatment than professional tattoos, though amateur tattoos are less predictable. This is because the amateur tattoo has reached a low level from the surface of the skin. Tattoo location, or pores and skin type in this study had no effect on the consistency of the findings.

For the treatment of amateur tattoo placed on the arm (Figure-1-C, D), the tattoo pigment could be completely removed in just three treatments and a perfect end-result was achieved. However, tattoos on distal extremities, for amateurs or practitioners alike, are probably more difficult to treat due to reduced lymphatic drainage of phagocytic pigment.[19]

Further research on this new tattoo removal method should be undertaken. In this study, very good results were observed with 3 consecutive laser exposures at 10 J / cm^2, 3-mm spot, 100-nanosecond pulse duration and a time delay of 20 minutes. These parameters are certainly not ideal. Higher laser fluency is generally more effective. Larger laser spot dimensions are associated with improved fluency and tattoo clearance. The laser ND: YAG (1064 nm) is more effective in black ink tattoos, which strongly absorb all available Q-switched laser wavelengths because of its greater penetration depth. The shorter pulse duration is also well established, especially when compared to picosecond with

nanosecond laser pulses Efficient for removal of tattoos.[20-22]

This and other knowledge from previous tattoo removal studies is probably applicable to the R20 method improvement. Many other parameters are not discussed in this study and warrant further research. An increase in laser fluency between consecutive exposures, for example, may allow the laser stream to penetrate deeper into the dermis. In short, we describe a much more effective method for laser removal of tattoos in a single treatment session, using existing Q-switched laser technology. Very many people have unwanted tattoos but donot undertake laser treatment due to cost and ambiguity. Hopefully delayed laser treatment with multiple passes will significantly change this situation.

Conclusion

Q-switched NDYAG laser using R20 methods is more effective, economical and less time consuming than traditional methods for removing tattoos either professional or amateur, with no late side effect especially scaring.

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