

Case Report

Longer Intervals Between Sessions With Q-Switched and Picosecond Lasers Result in Enhanced Tattoo Ink Clearance: Case Study Series of 12 Patients

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Abstract

Twelve case studies are presented showing results following laser tattoo removal with Nd:YAG, ruby and alexandrite lasers utilising both nanosecond and picosecond pulsewidth modes in a range of applied radiant exposures (fluences). The lockdowns around the world during the COVID-19 pandemic in 2020 and 2021 resulted in a situation where many laser treatments stopped - sometimes for many months. On returning to treatment, many anecdotal reports began to circulate pointing out 'exceptional' ink clearance since the previous laser treatments. The data and photographs presented here were compiled from nine centres in the UK, USA and Canada.

Keywords: Laser Tattoo; Tattoo Removal; Nd:YAG, COVID-19 Pandemic

Introduction

Standard protocols for laser tattoo removal with Q-switched Nd:YAG lasers generally suggest a period of between four and eight weeks between repeat sessions [1-5]. The initial, ground-breaking studies in the early 1980s suggested four weeks, but this intra-treatment period has lengthened over the subsequent years to between four and eight weeks [1-10]. In addition, it is generally accepted that anywhere between 4 and 15 repeat sessions may be required to remove a 'typical' professionally applied tattoo with QS lasers [4-7].

The question as to the 'optimal' period between treatment sessions has not been properly addressed (to the author's knowledge). In this report I present the results in the treatment of twelve patients from nine clinical centres across the planet. Many, not all, of these results were obtained after the COVID-19 lockdowns in 2020 and 2021 which stopped many laser treatments in many countries.

Case Report

Twelve case studies are presented below.

Case 1: DermaLase DL2500 QS Nd:YAG laser (Table 1,2, Fig. 1)

Ethnicity	Caucasian
Fitzpatrick	2
Age (years)	23
Wavelength (nm)	1064
Fluence (J/cm ²)	2 - 4
Pulsewidth (ns)	10
Other information	Patient described as a 'fit and healthy' person

Table 1: DermaLase DL2500 QS Nd:YAG laser.

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Figure 1: Before treatment and after 4 sessions over a period of 51 months, this photo was taken 7 months after the last treatment.

Treatment	Date	Gap (months)
1	July 2014	-
2	February 2016	19
3	January 2017	11
4	October 2018	21

Table 2: Treatment details as per the month gap.

The photographs show excellent clearance after only four sessions. The final photograph was taken seven months after the last laser treatment in October 2018. It is clearly evident that more than 95% of the original ink appears to have been removed throughout the course of these four treatments.

Credit: DermaLase Research Unit, Glasgow, Scotland

Case 2: DermaLase DL2500 QS Nd:YAG laser (Table 3,4, Fig. 2)

Ethnicity	Caucasian
Fitzpatrick	2
Age (years)	29
Wavelength (nm)	1064
Fluence (J/cm ²)	1 st session- 2.4 2 nd session- 3.5
Pulsewidth (ns)	10

Table 3: DermaLase DL2500 QS Nd:YAG laser.



Figure 2: Before treatment and after 2 treatments - immediately prior to the 3rd treatment-August 2021.

Treatment	Date	Gap (months)
1	October 2017	-
2	April 2018	6
3	August 2021	40

Table 4: Treatment details as per the month gap.

It is evident that the red and green pigments faded over the time period, even though they were only treated with the 1064nm wavelength. However, the dark blue/black pigment has faded significantly during this period.

Credit: DermaLase Research Unit, Glasgow, Scotland

Case 3: AW3 QS Nd:YAG laser (Table 5,6, Fig. 3)

Ethnicity	Caucasian
Fitzpatrick	2
Age (years)	27
Wavelength (nm)	1064
Fluence (J/cm ²)	2
Pulsewidth (ns)	8
Other information	Patient stopped due to pregnancy

Table 5: AW3 QS Nd:YAG laser.



Figure 3: Before treatment-Sept 2020 and photo taken 26.9.21, 12 months after 1st treatment and taken prior to the third treatment session in April 2022.

Treatment	Date	Gap (months)
1	September 2020	1
2	September 2021	12
3	April 2022	7

Table 6: Treatment details as per the month gap.

This tattoo patient was treated 12 months after her first session, due to pregnancy. The third photo (above) was taken immediately prior to the third treatment, 7 months after the second session.

Credit: Claire-Louise Skin Aesthetics, Ilminster, England

Case 4: Titan 3 QS Nd:YAG laser (Table 7,8, Fig. 4)

Ethnicity	Caucasian
Fitzpatrick	3
Age (years)	27
Wavelength (nm)	1064
Fluence (J/cm ²)	4.5
Pulsewidth (ns)	3.5

Table 7: Titan 3 QS Nd:YAG laser.



Figure 4: Before first treatment and photo taken November 2021-13 months after the second treatment.

Treatment	Date	Gap (months)
1	July 2020	-
2	Oct 2020	3
3	Nov 2021	13

Table 8: Treatment details as per the month gap.

Only two treatments have been applied to this patient, by November 2021, yet a significant clearance is evident.
Credit: Megan Stacey, Laser Meg Ltd, Wales

Case 5: Cynosure Picosure Alexandrite laser (Table 9,10, Fig. 5)

Ethnicity	Caucasian
Fitzpatrick	3
Age (years)	33
Wavelength (nm)	755
Fluence (J/cm ²)	1 st session - 3.5 2 nd session - 3.0
Pulsewidth (ns)	0.75

Table 9: Cynosure Picosure Alexandrite laser.



Figure 5: Before first treatment and photo taken in October 2021, 5 months after second treatment.

Treatment	Date	Gap (months)
1	March 2021	-
2	May 2021	2
3	October 2021	5

Table 10: Treatment details as per the month gap.

Credit: Craig Gilbert, Adrenaline VanCity, Vancouver, BC, Canada

Case 6: OptiLight PermaNano QS Nd:YAG and QS ruby lasers (Table 11,12, Fig. 6)

Ethnicity	Caucasian
Fitzpatrick	2
Age (years)	Mid 40s
Wavelength (nm)	1064, 532 & 694
Fluence (J/cm ²)	1 st session - 1.2 (@1064), 0.4 (@532) 2 nd session - 2.0 (@1064), 1 (@532) 3 rd session -2.4 (@1064), 1.2 (@532)

	4 th session - 3.0 (@1064), 3 (@532), 1.3 (@694)
Pulsewidth (ns)	Nd:YAG (1064, 532nm) :- 3.5 ns Ruby (694nm)- 10 - 15 ns

Table 11: OptiLight PermaNano QS Nd:YAG and QS ruby lasers.



Figure 6: This tattoo had four treatment sessions overall.

Treatment	Date	Gap (months)
1	Feb 2020	-
2	July 2020	5
3	Sept 2020	2
4	Sept 2021	12

Table 12: Treatment details as per the month gap.

Credit: - Ben Hartley, ClearLase Tattoo Removal, Sheffield, England

Case 7: Quanta Evo Q Plus C QS Nd:YAG laser (Table 13,14, Fig. 7)

Ethnicity	Caucasian
Fitzpatrick	3
Age (years)	32
Wavelength (nm)	1064
Fluence (J/cm ²)	4.0
Pulsewidth (ns)	6

Table 13: Quanta Evo Q Plus C QS Nd:YAG laser.



Figure 7: After only one session this tattoo exhibits an excellent amount of ink clearance.

Treatment	Date	Gap (months)
1	31 July 2021	-
2	22 June 2023	23

Table 14: Treatment details as per the month gap.

Credit: Billy Shippers, Shippers Laser Tattoo Removal Center, LLC., Allen, Texas USA.

Case 8: Titan 3 QS Nd:YAG laser (Table 15,16, Fig. 8)

Ethnicity	Caucasian
Fitzpatrick	2
Age (years)	29
Wavelength (nm)	1064
Fluence (J/cm ²)	4.4
Pulsewidth (ns)	10

Table 15: Titan 3 QS Nd:YAG laser.



Figure 8: Before treatment and four years after 1 treatment.

Treatment	Date	Gap (months)
1	August 2020	-
2	February 2022	18

Table 16: Treatment details as per the month gap.

In this example, the tattoo received only one laser session, yet the fading has been significant over the subsequent 18 month period. This appears to show that ink clearance can continue long after one laser application.

Credit: Megan Stacey, Laser Meg Ltd, Wales

Case 9: Quanta Q Plus C QS Nd:YAG laser (Table 17,18, Fig. 9)

Ethnicity	Caucasian
Fitzpatrick	2
Age (years)	26
Wavelength (nm)	1064
Fluence (J/cm ²)	2.5
Pulsewidth (ns)	6

Table 17: Quanta Q Plus C QS Nd:YAG laser.



Figure 9: Before any treatment. Final photograph taken 21 months after one treatment session.

Treatment	Date	Gap (months)
1	Nov 2019	-
2	July 2021	21

Table 18: Treatment details as per the month gap.

Credit: Liz O'Keane, Shattered Ink Laser, Bury, England

Case 10: Quanta Q Plus C QS Nd:YAG laser (Table 19,20, Fig. 10)

Ethnicity	Caucasian
Fitzpatrick	3
Age (years)	32
Wavelength (nm)	1064
Fluence (J/cm ²)	1 st session - 2.8 2 nd session - 3.8 3 rd session - 4.0
Pulsewidth (ns)	10

Table 19: Quanta Q Plus C QS Nd:YAG laser.



Figure 10: Before any treatment. Final photograph taken after three treatment sessions. Second photo taken 8 months after the third session.

Treatment	Date	Gap (months)
1	Dec 2020	-
2	Apr 2021	5
3	Nov 2021	7

Table 20: Treatment details as per the month gap.

Credit: Liz O’Keane, Shattered Ink Laser, Bury, England

Case 11: JM QS Nd:YAG laser(Table 21,22, Fig. 11)

Ethnicity	Caucasian
Age (years)	28
Wavelength (nm)	1064
Fluence (J/cm²)	3.0
Pulsewidth (ns)	5

Table 21: JM QS Nd:YAG laser.



Figure 11: Another example of a good result after only one session. Final photo taken at in September 2022 six months after the second treatment.

Treatment	Date	Gap (months)
1	Jan 2020	-
2	Mar 2022	26

Table 22: Treatment details as per the month gap.

Credit: Rachel Leith, VAHALLA Tattoo Studios, Kilmarnock, Scotland

Case 12: *Astanza Duality QS Nd:YAG laser* (Table 23,24, Fig. 12)

Ethnicity	Hispanic
Fitzpatrick	4
Age (years)	28
Wavelength (nm)	1064
Fluence (J/cm ²)	4.0
Pulsewidth (ns)	6
Other information	Patient described as a 'fit' person

Table 23: Astanza Duality QS Nd:YAG laser.



Figure 12: The first photo was taken prior to treatment on March 27th, 2020. The second photo was taken on July 2nd, 2024 more than a four year gap with only one laser session.

Treatment	Date	Gap (months)
1	March 2020	-
2	July 2024	51

Table 24: Treatment details as per the month gap.

Credit: Ned Moore, North Houston Laser Tattoo Removal, Texas, USA

Discussion

The data and photographs presented were garnered from nine independent treatment centres in the UK, Canada and the USA. Most of these results come from the application of Q-switched Nd:YAG lasers, but that does not appear to be particularly important, as similar results were generated with both ruby and alexandrite lasers - nano- and picosecond.

There has been an awareness among some laser tattoo practitioners, for some time, that 'good' results may be achieved by leaving

long periods between repeat sessions. This is entirely due to the body's natural wound healing response following laser irradiation, which can vary significantly between patients due to age, fitness, body location and tattoo ink constituents. It appears that 'standard' protocols do not reflect the importance of this post-treatment healing time. The suggested interval between treatments sessions is typically quoted as between 4 and 8 weeks [1-7]. Indeed, this particular part of the clinical protocol is rarely discussed in the literature or is often regarded as relatively unimportant [8-14].

Phagocytosis and lymphatic removal clearly require significant times to remove as much of the fragmented ink aggregates as possible. As of now, the optimal time is unknown, but the author now recommends waiting at least twelve weeks and possibly longer, between repeat sessions. Given that the skin's healing processes are complex and can take up to two years following traumatic injury, this appears to be a more sensible approach [15].

Localised scarring has been observed at the microscopic level around ink aggregates in histological samples, both from the original tattooing process and all subsequent laser treatments [16,17]. While this is usually not visible to the human eye, it is cumulative following laser sessions. Hence, more treatment sessions will result in more micro-scarring tissue formation which may become visible after a certain number of treatments. This suggests that minimising the total number of laser treatments is a better option, in terms of the final aesthetic result.

During laser treatment, many of the fibroblast/macrophage-encapsulated ink particles are released back into the dermis [11,12,16-18]. Essentially, the conditions which are found immediately after the original tattooing process, re-occur. Many free particles of ink are located throughout the dermis. Undoubtedly, the same processes which occur soon after a new tattoo is injected into the skin, will be repeated - phagocytosis, encapsulation of ink particles by dermal macrophages and tissue repair, etc [19].

As a consequence, some of the particles will be removed from the dermis and deposited in the lymph nodes. Other particles will form new aggregates through electrostatic (van der Waals) forces and be subsequently absorbed by dermal macrophages, fibroblasts and mast cells and remain in the dermis - as before [19,20].

The Kirby-Desai scale, often used to predict the overall number of treatment sessions required to effect a successful tattoo removal, does not include the interval between sessions in its algorithm [21]. Their scale assigns numbers to six factors which are considered to be important: the patient's Fitzpatrick skin type, tattoo colour and body location, the amount of ink in the tattoo, ink layering and the inherent scarring or tissue changes. They do not consider the interval between session and simply quote the 'standard' interval of "6 to 8 weeks". Yet, the results presented here clearly indicate that this interval should be a key consideration when calculating the number of sessions needed.

Aurangabadkar, et al., applied the R0 technique and compared the number of sessions with the predicted number using the Kirby-Desai scale [22]. The R0 technique involves multiple treatments on a tattooed area within a short time (typically 5 to 20 minutes), using Perfluorodecalin (PFD) to enhance the optical conditions in the dermis following laser applications. They found that this technique, when applied to skin phototypes IV to VI required 'significantly' fewer sessions than predicted by the Kirby-Desai scale.

Pedrelli, et.al., investigated the number of sessions required using a picosecond laser and found that around 25% fewer treatments were needed compared with the expected results from a Q-switched (nanosecond) laser, based on the Kirby-Desai scale [23]. However, they also assumed a 'standard' 6 to 8 week interval between sessions and did not appear to consider this to be a particularly important issue.

Naga also suggests that the Kirby-Desai scale is limited due to lack of consideration of the wavelength and pulse width [5].

These studies all showed that the total number of treatment sessions required depends on a number of factors, including the original factors described by Kirby-Desai. However, none of them properly considered the interval between repeat sessions.

Baranska, et al., found that the persistence of tattoo ink aggregates in mice skin is due to dermal macrophages retaining the ink

aggregates in situ [19]. The application of laser energy induces explosive changes in these macrophages releasing the ink fragments into the dermis. Baranska found that a portion of the ink particles were likely to be removed by lymphatic macrophages, but the remaining particles/aggregates were left in the dermis to be subsequently consumed by new dermal macrophages. However, the timing of these processes is dependent on the local supply of dermal macrophages, which Baranska found to be of a significantly 'long duration'. They suggest that a new approach utilising the ablation of the surviving dermal macrophages, immediately after laser treatment of the ink-laden macrophages, thereby minimising the likelihood of recapture of the ink aggregates (although how this 'ablation' may be administered was not discussed).

The fact that ink clearance may continue for many months after just one laser treatment session indicates that the conditions in the dermis after such a session are not the same as directly after the original tattooing process. This suggests that the supply of dermal macrophages after a laser session is somehow disrupted or interfered with, leading to a lack of new ink-capsulating cells.

It may be that the optimum interval between sessions is linked to the replenishment time of the dermal macrophages. However, given that ink can still be removed many months after a single laser treatment indicates that something fundamental must have changed in the dermis, in terms of the wound repair processes. Most fresh tattoos 'heal' within three to four months of injection, with a very slow ink clearance rate thereafter. But following a laser treatment, the ink clearance can continue to remain relatively high, by comparison, implying a different physiological mechanism.

The results presented here appear to show that the pulsewidth of the laser is not as important as previously thought. While there are bound to be significant differences in ink clearance rates between patients, regardless of the technology used, it does appear that leaving a longer gap between treatment sessions has a significant overall effect on the outcome, regardless of the pulsewidth.

All of the data presented here came from commercial tattoo removal clinics. As such, it is not accurate to describe these as emanating from clinical studies - they are simply collections of actual experiences following an unprecedented worldwide situation. Consequently, this data cannot be viewed as scientifically rigorous. It merely serves to stimulate discussion among laser users and researchers [20-23].

Conclusion

The COVID-19 pandemic created a highly unusual situation when many laser tattoo treatments were stopped for long periods, due to lockdowns around the world. When treatments recommenced, many laser operators noticed a striking difference in their patients' tattoos, reporting enhanced ink clearance - more than they had expected under normal conditions. The rate of ink clearance, following laser tattoo removal, is likely dependent on the patient's age, state of health and fitness, condition of their skin, dietary and smoking habits and their general skin hygiene. As such, the clearance rate is very patient-dependent - the equipment does not appear to have much influence on this rate. Clearly, not every tattoo treatment will respond in the same manner. Some will likely require many treatments, regardless of the intervals between sessions. However, the rate of ink clearance depends on the skin's natural healing processes, which typically requires months, not weeks. It appears that laser tattoo removal treatment sessions have been too frequent, since its inception in 1981. Interestingly, the overall time required for an effective removal of the ink is around the same regardless of whether many sessions occur at a relatively high frequency or a lower total number of sessions at a lower frequency. It seems that most researchers in this field place more emphasis on the technology used rather than the subsequent biological processes and timings. This appears to be a mistake.

Conflict of Interests

The authors declare that there is no conflict of interest for this paper.

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