

SHORT REPORT

Tattoo removal by Q-switched yttrium aluminium garnet laser: client satisfaction

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Abstract

Background Tattoo removal by Q-switched yttrium aluminium garnet (YAG) lasers is golden standard; however, clients' satisfaction with treatment is little known.

Objective To determine clients' satisfaction with tattoo removal.

Methods One hundred and fifty-four tattoo removal clients who had attended the private clinic 'Centre for Laser Surgery', Hellerup, Denmark, from 2001 to 2013 completed a questionnaire concerning outcome expectations, level of pain experiences and satisfaction with tattoo removal. The laser surgeon and his team were blinded from data handling. The study design included a minimum 2-year postlaser treatment observation period from 2013 to 2015.

Results Overall, clients were satisfied with their laser treatment; 85% assessed their treatment and results to be acceptable to superb, while 15% assessed their treatment and results to be inferior to unacceptable. Effectiveness relative to colour of tattoo on a scale from 0 (no effect) to 10 (complete removal) scored a mean of blue 9.5, black 9.4, yellow 8.9, red 8.8 and green 6.5. Clients were dissatisfied with green pigment remnants, which could mimic bruising. One hundred and twenty-nine clients (84%) experienced moderate to extreme pain during treatment. Twenty-eight (20%) developed minor scarring. There were many reasons for tattoo removal; e.g. stigmatisation (33%), conspicuousness (29%) and poor artistic quality (22%). One hundred and two clients had expected complete removal of tattoos without a blemish, expectations that were only partly fulfilled. During the treatment period, clients adjusted expectations and adapted more realistic views of outcomes.

Conclusion The majority of clients were satisfied with Q-switched YAG laser removal of tattoos despite high pretreatment expectations which were only partly met. The study supports YAG lasers for tattoo removal as acceptable therapy of today, with room for new approaches.

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Conflicts of interest

We have no conflict of interest to disclose.

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Introduction

Parallel to the worldwide popularity of tattoos, Q-switched yttrium aluminium garnet (YAG) laser has become the preferred method for tattoo removal due to the very short impulse that limits the thermal damage of the treated skin.¹⁻⁴ Picosecond lasers were recently introduced aiming at further reduction of thermal damage of the skin and better tattoo clearance.⁵⁻⁷ However, advantages and cost-effectiveness of new picosecond lasers remain to be documented.

In medical literature, client satisfaction of tattoo removal by laser is little studied and, therefore, difficult to conclude.

Reports are few and with effectiveness evaluated from pre- and postdigital images by dermatologists or with the use of different equipments, settings, technicalities and preconditions.⁸⁻¹⁷ There does not appear to have been published *any* systematic studies on client satisfaction despite the importance of the subjective outcome. Many other aspects than fading of tattoo colour may be relevant in clients' appreciation of treatment outcomes.

Our study is a retrospective assessment of client satisfaction of tattoo removal by YAG laser. The study evaluations were independent of the laser surgeon and thus partly blinded.

Methods/Materials

The study is a retrospective questionnaire evaluation with follow-up assessment of clients' satisfaction with nanosecond YAG laser removal of tattoos. Clients' tattoo regrets were for non-medical reasons. Study method is shown in Fig. 1.

Participants

Clients who had received Q-1064 YAG laser treatments on tattoos at the private clinic 'Centre for Laser Surgery' from 2001 to 2013 were invited. In Denmark, there is no public subsidiary for laser removal of tattoos on the reason of regret.

Invitations to participate were delivered during March–August 2015 via postal service. The design included a 2-year post-treatment observation period from 2013 to 2015 allowing assessment outcome as distinction between immediate lightening after treatments and late-onset effects.¹⁸ Focus was on late-onset effects and participants who had no further scheduled treatments. Questionnaire topics evaluated demographic data, professional/amateur tattooist, health status, skin type, predisposition, previous treatments, reasons for removal, pretreatment expectations, pain, effectiveness, complications, satisfaction, new tattoos and further comments.

Laser treatments

A Q-switched neodymium-doped YAG laser [Versapuls laser; Coherent, Palo Alto, CA, USA (2001–2004) and the Revlite laser; Conbio, Fremont, CA, USA (2005–2014)], were employed with infrared light wavelength 1064 nm for black colours and 532 nm for red colours. Since 2005, additional wavelengths of 585 nm and 650 nm have been used to treat blue and green colours. The pulse duration for all wavelengths

was in the range 3–5 ns, spot size of 4–8 mm with a repetition rate up to 10 Hz. Clients received between 1 and 24 laser treatments dependent on laser surgeon and clients decisions, with an interval of minimum 6 weeks. All tattoos had been photographed both prior to and after laser treatments.

Prior to treatments, the dermatologist of the centre assessed all clients. Contraindications to treatment were signs or history of allergic reaction in the tattoo, or scarring. Clients with multi-coloured tattoos were deterred from initiating treatment due to recognised, poor cosmetic results.

Most clients were treated without anaesthesia; however, some small tattoos in sensitive areas were anesthetized with lidocaine 2% adrenaline. Treatment termination was defined by virtue of a white discoloration of the tattoo without blistering or bleeding. Immediately after treatment, the treated areas were cooled with ice. Postcare treatment was a disinfectant moisturizer.

Results

One hundred and fourteen females and 40 males constituted the 154 clients included in the evaluation. All participants declared they were healthy at time of treatments. General information on participants is given in Table 1. Reasons for tattoo removal are given in Table 2.

Pretreatment expectations

Clients were orally informed of side-effects, complications and potential imperfection of ink removal prior to treatments. Nevertheless, 102 clients expected complete removal of tattoos without any blemish. Ten expected near optimal removal, 36 expected partial removal/bleaching and two expected complete removal although with some scarring. Two had decided to have

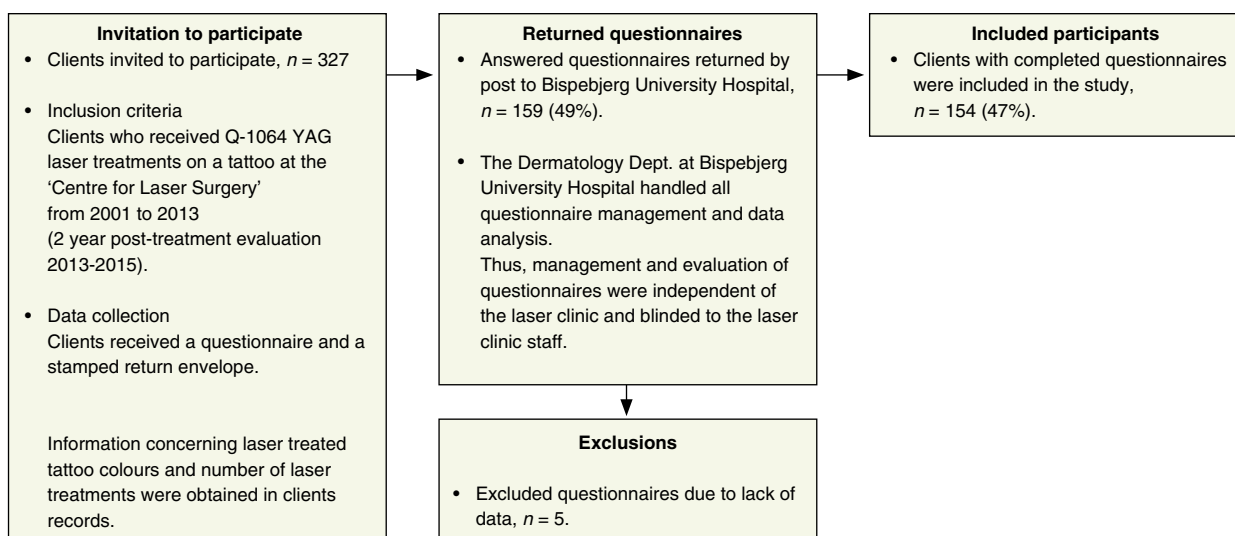


Figure 1 Study method and material, flow chart.

Table 1 General information on the 154 clients and detailed information on the tattoos they wished to be removed. Many clients requested removal of a tattoo with more than one colour, which also included black linings. A total number of tattoos treated were 175

| | |
|----------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Number of participants | 154 (114 females, 40 males) |
| Mean age at tattooing | 24 years (range 15–56) |
| Length of time with tattoo before removal | 1 week to 50 years before laser removal |
| Skin type (Fitzpatrick scale) | Type I: 7 clients Type II: 40 clients Type III: 82 Type IV: 24 clients Type V: 1 client |
| Professional/amateur tattooist* | Professional: 125 Amateur: 14 Professional and amateur: 8 Not known: 7 |
| Colours to be removed | Black: 149 (97%) Red: 48 (32%) Green: 45 (29%) Blue: 22 (14%) Yellow: 19 (12%) Purple: 6 (4%) Orange: 5 (3%) Brown: 2 (2%) Grey: 1 (0.7%) Turquoise: 1 (0.7%) |
| Localisation of the tattoo to be removed | Shoulder: 49 (28%) Upper arm: 26 (15%) Lower arm: 24 (14%) Back: 13 (7%) Lower leg: 13 (7%) Chest: 11 (6%) Hands/fingers: 9 (5%) Abdomen: 9 (5%) Buttock: 8 (5%) Foot: 8 (5%) Face: 3 (2%) Neck: 1 (0.5%) Genitals: 1 (0.5%) |
| Previous laser treatments performed at other clinics prior to study† | 28 clients (18%) |

*Professional tattooists in Denmark are defined as experienced tattooists working in a tattoo parlour, contra amateur tattooists who perform tattoos at home or under primitive conditions.

†Various reasons for choosing the 'Centre for Laser Surgery' were given, e.g. low effectiveness of previous laser treatments, advice from friends and family, lower price and neighbouring vicinity to the Centre. Fourteen clients had laser scars due to previous laser treatments or due to trauma from the tattooing procedure.

a cover-up tattoo and, therefore, only requested bleaching. Two were not convinced of effective removal but gave treatment a chance.

Table 2 Clients' declared reasons for having their tattoos removed ($n = 154$). Clients were allowed to mark more than one reason to the suggested list of predefined reasons ($n = 290$) and add spontaneous comments

| Reasons | Number | % |
|-------------------------------------|--------|-----|
| Stigmatisation | 51 | 33 |
| Conspicuousness | 45 | 29 |
| Poor artistic quality of the tattoo | 34 | 22 |
| Matured since tattoo engraving* | 28 | 18 |
| Tattoo motif not as anticipated | 23 | 15 |
| Unwanted detail (name/text) | 21 | 14 |
| Tattoo outdated | 18 | 12 |
| Tattoo too big | 15 | 10 |
| Problems related to job | 13 | 8 |
| Tattoo related to previous partner* | 11 | 7 |
| Tattoo fading over time | 11 | 7 |
| Felt unfeminine* | 6 | 4 |
| Ink leaking into surrounding skin | 6 | 4 |
| Disfiguring scarring | 3 | 2 |
| Simply regretted (not specified)* | 3 | 2 |
| Allergic reaction | 1 | 0.6 |
| Sun sensitivity | 1 | 0.6 |

*Spontaneous comments from clients.

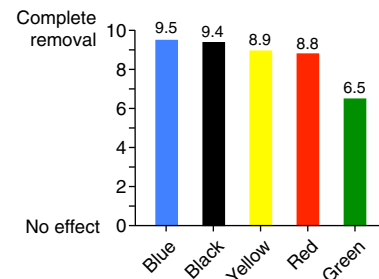


Figure 2 Clients' assessment of tattoo removal by laser relative to colours, rated on a visual analogue scale (VAS 0–10) with the total material of 154 clients including clients who did not fulfil a full laser treatment course.

Results of laser treatments

Treatment was rated by each client on a VAS from 0 (no effect at all) to 10 (complete removal). Colour was rated individually (Fig. 2). In total, 111 of the 154 (72%) clients completed a full course of laser removal. Evaluations are presented in Table 3.

Dark colours were rated highest, green lowest. Photographs of tattoos are presented in Fig. 3.

Other colours Three clients with orange coloured tattoos completed laser courses and awarded scores between 3 and 10, mean 6.3. One client with a turquoise coloured tattoo awarded a score of 8. Two clients with brown coloured tattoos awarded a score of 10. Two clients with purple coloured tattoos also awarded a

Table 3 Clients' satisfaction with tattoo removal by laser relative to tattoo colour, rated on a VAS (visual analogue scale from 0 to 10) in 111 (72%) of 154 clients, who completed the full laser treatment course

| Colours to be removed | Number of tattoos related to colour | Client satisfaction by VAS, median and range |
|-----------------------|-------------------------------------|----------------------------------------------|
| Blue | 12 | 9.5 (6–10) |
| Black | 107 | 9.3 (5–10) |
| Red | 25 | 8.8 (2–10) |
| Yellow | 8 | 8.5 (6–10) |
| Green | 21 | 6.5 (0–10) |

Results obtained in the total material of 154 clients are shown in Fig. 2.

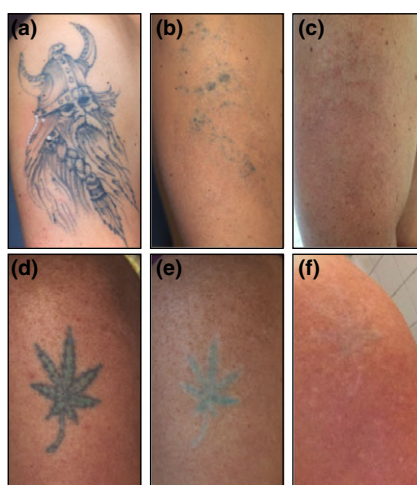


Figure 3 Clinical photographs. (a–c). Client with a black tattoo on his upper arm. He was 18 when he acquired the tattoo; after 9 years, he wanted it removed. Photograph taken prior to treatment, after five laser treatments and after 10 treatments. (d–f). Client with a green tattoo on her upper arm. She was 18 when she acquired the tattoo; after 18 years, she wanted it removed. Photograph taken prior to treatment, after seven laser treatments and after 10 treatments. In this case, outcome was remarkably favourable.

score of 10. One client with a grey coloured tattoo awarded a score of 9.5.

Pain and complications

In total, 129 clients (84%) experienced pain from moderate to extreme during treatments. Evaluations on pain and complications are given in Table 4.

Several tattoos removed

Thirty-five clients had several tattoos treated. Twelve (34%) observed a divergence in the results of tattoos treated with the same laser procedure. Some tattoos were more swollen after treatment, some faded faster or itched, while others were complicated with scarring. Tattoos were of different colours, anatomical sites and tattoo techniques.

Overall assessment of treatments

Overall assessment was rated from superb to unacceptable; Fig. 4.

Cover-up tattoos after laser treatment

Twenty-nine clients (19%) had new tattoos applied at any body site after the laser course; of these, 12 (41%) had cover-up tattoos applied on the laser treated area. One hundred and twenty-five of the 154 (81%) had *not* acquired any new tattoos after treatment. Thirteen (11%) considered cover-up tattoos but had not acted yet.

Completion of laser treatments

Forty-three (28%) did not complete the full laser treatment course. Sixteen terminated treatments due to lack of time, logistic difficulty, affordability or pain, 13 terminated treatments due to lack of effect. Two had a cover-up tattoo, and two were satisfied with the results at an early stage during treatment. Five paused their treatments and stated passiveness as the reason for not resuming treatments. Five did not give a reason for not completing.

Table 4 Pain during laser treatment and complications after laser treatments

| Pain during treatment* | | | | |
|-------------------------------|---------------------|--------------------|------------------|-----------------|
| Extremely painful | Very painful | Moderately painful | Little painful | Not painful |
| 31 clients (20%) | 34 clients (22%) | 55 clients (36%) | 22 clients (14%) | 1 client (0.6%) |
| Complications after treatment | | | | |
| Infections, bacterial | Abnormal sensations | Minor scarring† | Hypopigmentation | Shininess |
| 2 clients (1.3%) | 5 clients (3%) | 28 clients (20%) | 46 clients (33%) | 11 clients (8%) |

*Some clients had difficulty in determining pain level and therefore rated pain in-between two predefined groups; five clients experienced treatments as in-between moderate to very painful, three in-between extremely painful and very painful, one wavered between little painful to moderate painful. One received local anaesthesia, and another client was undecided as first treatment was extremely painful and the last treatment was not painful at all.

†One hundred and forty of 154 responders had no scarring prior to treatments at the 'Centre for Laser Surgery', while 14 had scars after previous attempts at other clinics to remove tattoos or after trauma from tattooing. Of these 140 clients, 28 clients developed minor scarring (20%).

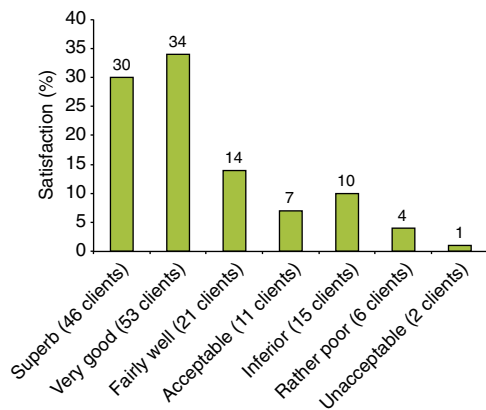


Figure 4 Clients' overall satisfaction with tattoo removal by laser ($n = 154$).

Discussion

One hundred and fifty-four clients' overall response to tattoo removal by Q-switched nanosecond laser was satisfactory despite high pretreatment expectations only being partly met.

Medical literature has few and rather small follow-up studies on laser removal of tattoos contrasting the large activity of removal on a global scale. Outcomes are typically assessed by the treating clinic having a commercial interest. In this study, we blinded all data handling and analysis to the 'Centre for Laser Surgery' to minimise potential influence or bias related to clients–therapist interactions. The ultimate goal of tattoo removal by laser is a satisfied client and not primarily a satisfied laser surgeon.

One hundred and two (66%) clients expected, despite surgeon's detailed information outlining risks and outcomes, complete removal of their tattoos however; only 46 (30%) achieved what they considered 'superb' results. Nevertheless, 131 (85%) considered treatment outcome acceptable to superb at follow-up appointments. Clients apparently became educated through practical experience with laser removal sessions in the direction of better acceptance of sub-optimal outcomes. Thus, patient education prior to and during treatment is important.

Results of laser removal of colours blue, black, red, yellow and green showed that green undoubtedly, proved to be the most difficult colour to remove and therefore, scored the lowest on the client's satisfaction scale. It is a surprising result because the YAG laser light is not absorbed in yellow and thus, not expected to be effective in removing this colour. Some clients indicated that dissatisfaction with incomplete removal of green was due to subsequent resemblance to a blunt skin trauma with haematoma. The colour yellow is relatively close to natural skin colour, and thus, only minor bleaching may be rated satisfactory. Bleaching of tattoo colours after laser removal is not simply a function of emitted laser light from a system and physical

absorbance. Inflammation of the healing process and mild fibrosis can help the tattoo appear faded in colour, as yellow tattoos may exemplify.¹

We found that 80% reported *no* scarring, however, as known and confirmed, laser removal is very painful and complications may occur even in the hands of a qualified laser surgeon.

Picosecond lasers have been introduced to remove tattoos easier and safer, as the pulse duration is shorter and the peak energy higher, resulting in finer fragmentation of pigment and faster clearing of the pigments by the lymphatic system.¹⁹ In 2015, a study of 31 tattoo removals by a picosecond-domain, frequency-doubled Nd: YAG laser system (PicoWay, Syneron Candela Corp; Wayland, MA, USA), was conducted.²⁰ Three blinded investigators evaluated digital images of tattoos and rated them on a 10-point scale from 0 (least clearance) to 10 (total clearance). Results are very similar to our results; however, we used a Q-switched nanosecond laser, and clients rated evaluations from 0 to 10 themselves. Both the picosecond laser and the Q-switched nanosecond laser used in our study had exactly the same difficulty in removing green pigment.

There is obviously a need for head-to-head, comparative studies of gold standard Q-switched nanosecond lasers vs. picosecond lasers used for tattoo removal.

References

- Eklund Y, Rubin AT. Laser tattoo removal, precautions, and unwanted effects. *Curr Probl Dermatol* 2015; **48**: 88–96.
- Verhaeghe E. Techniques and devices used for tattoo removal. In De Cuyper C, Pérez-Cotapos ML, eds. *Dermatologic Complications with Body Art*. Springer-Verlag, Berlin, Heidelberg, 2010: 91–105.
- Williams N. Quality-switched laser tattoo removal. *JAAPA* 2014; **27**: 53–56.
- Khunger N, Molpariya A, Khunger A. Complications of tattoos and tattoo removal: stop and think before you ink. *J Cutan Aesthet Surg* 2015; **8**: 30–36.
- Hsu VM, Aldahan AS, Mlacker S, Shah VV, Nouri K. The picosecond laser for tattoo removal. *Lasers Med Sci* 2016; **31**: 1733–1737.
- Izickson L, Farinelli W, Sakamoto F, Tannous Z, Anderson RR. Safety and effectiveness of black tattoo clearance in a pig model after a single treatment with a novel 758 nm 500 picosecond laser: a pilot study. *Lasers Surg Med* 2010; **42**: 640–646.
- Ross V, Naseef G, Lin G *et al.* Comparison of responses of tattoos to picosecond and nanosecond Q-switched neodymium: YAG lasers. *Arch Dermatol* 1998; **134**: 167–171.
- Lakshmi C, Krishnaswamy G. Efficacy of the Q-switched neodymium: yttrium aluminum garnet laser in the treatment of blue-black amateur and professional tattoos. *Indian J Dermatol* 2015; **60**: 578–583.
- Biesman BS, O'Neil MP, Costner C. Rapid, high-fluence multi-pass q-switched laser treatment of tattoos with a transparent perfluorodecalin-infused patch: a pilot study. *Lasers Surg Med* 2015; **47**: 613–618.
- Reddy KK, Brauer JA, Anolik R *et al.* Topical perfluorodecalin resolves immediate whitening reactions and allows rapid effective multiple pass treatment of tattoos. *Lasers Surg Med* 2013; **45**: 76–80.
- Kossida T, Rigopoulos D, Katsambas A, Anderson RR. Optimal tattoo removal in a single laser session based on the method of repeated exposures. *J Am Acad Dermatol* 2012; **66**: 271–277.
- Sardana K, Ranjan R, Chakravarty P, Goel K, Tenani A, Madan A. Pigmented lesions and tattoos. In Sardana K, Garg VK, eds. *Lasers in*

- Dermatological Practice, 1st edn. Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, 2014: 101–171.
- 13 Barua S. Laser-tissue interaction in tattoo removal by Q-switched lasers. *J Cutan Aesthet Surg* 2015; **8**: 5–8.
 - 14 Weiss ET, Geronemus RG. Combining fractional resurfacing and Q-switched ruby laser for tattoo removal. *Dermatol Surg* 2011; **37**: 97–99.
 - 15 Aurangabadkar SJ. Shifting paradigm in laser tattoo removal. *J Cutan Aesthet Surg* 2015; **8**: 3–4.
 - 16 Mankowska A, Kasprzak W, Adamski Z. Long-term evaluation of ink clearance in tattoos with different color intensity using the 1064-nm Q-switched Nd:YAG laser. *J Cosmet Dermatol* 2015; **14**: 302–309.
 - 17 Sardana K, Ranjan R, Ghunawat S. Optimising laser tattoo removal. *J Cutan Aesthet Surg* 2015; **8**: 16–24.
 - 18 Karsai S, Raulin C. Laser treatment of tattoos and other dyschromia. In Raulin C, Karsai S, eds. *Laser and IPL Technology in Dermatology and Aesthetic Medicine*. Springer-Verlag, Berlin, Heidelberg, 2011: 189–202.
 - 19 Shah SD, Aurangabadkar SJ. Newer trends in laser tattoo removal. *J Cutan Aesthet Surg* 2015; **8**: 25–29.
 - 20 Bernstein EF, Schomacker KT, Basilavecchio LD, Plugis JM, Bhawalkar JD. A novel dual-wavelength, Nd:YAG, picosecond-domain laser safely and effectively removes multicolor tattoos. *Lasers Surg Med* 2015. DOI: 10.1002/lsm.22391 [Epub ahead of print].