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Comparison of treatment with an Alexandrite picosecond laser and Nd:YAG nanosecond laser for removing blue–black Chinese eyeliner tattoos

Mengli Zhang, Yuqing Huang, Tong Lin, and Qiuju Wu

Department of Cosmetic Laser Surgery, Hospital of Dermatology, Chinese Academy of Medical Sciences, Peking Union Medical College, Nanjing, China

ABSTRACT

Objective: To retrospectively evaluate the efficacy of an Alexandrite picosecond laser versus Nd:YAG nanosecond laser for removing blue–black eyeliner tattoos which have existed more than 10 years.
Methods: A total of 40 patients were treated with an Alexandrite picosecond laser in our department from August 2015 to July 2017, with a fluence of 1.96–6.37J/cm^2, spot size of 2.0–3.6 mm, and pulse width of 750 ps. Another 32 patients were treated with an Nd:YAG nanosecond laser, with a fluence of 2.80–7.00 J/cm^2, spot size of 3 mm, and pulse width of 5–20 ns. All analysed patients completed at least one treatment and follow-up.
Results: The median number of treatment for all the patients was 1 (range, 1–4). After a single session, no difference was found between the two lasers for the eyeliner removal ($p > 0.05$). For the people who achieved an excellent response of tattoo clearance, there was still no difference between the two groups ($p > 0.05$). Transient side effects were observed in two groups, but neither group had significant adverse reactions.
Conclusions: To treat blue–black Chinese eyeliner tattoos over 10 years, Alexandrite picosecond laser does not provide better clearance than the Nd:YAG nanosecond laser.

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Introduction

Cosmetic tattoos are often referred to as permanent makeup and include eyeliner, lip liner, or eyebrow tattoos. Cosmetic tattoos have become increasingly popular in recent years. Eyeliner tattoos, often the deposition of a blue–black pigment along the eyelid cilia in a linear fashion, are performed to enhance the appearance of the lash line. Removing undesired eyeliner tattoos is usually achieved by Q-switched nanosecond lasers (1). The primary mechanism underlying nanosecond laser-mediated tattoo removal is essentially targeted destruction of the tattoo pigments by specific laser light wavelengths. The fragmented pigments are then removed by lymphatic system or trans-epidermal elimination (2). In addition to the ruby and Alexandrite laser, the Q-switched Nd:YAG nanosecond laser, which has a pulse width in the range of 5–20 ns, is also considered to be the gold standard for removing tattoos. The picosecond laser with very short laser pulses (in the picosecond range) has also been shown to be effective in tattoo clearance in many clinical studies (3)

In this study, we retrospectively evaluated the efficacy of the Alexandrite picosecond laser and Nd:YAG nanosecond laser for removing blue–black eyeliner tattoos that were over 10 years of age in China.

Materials and methods

The data were collected from eyeliner-tattooed Chinese patients with Fitzpatrick skin type III–IV in our department from August 2015 to July 2017. Considering that tattoo age is an important factor that affects tattoo removal (4) and most eyeliner tattoos in our department are over 10 years old, we only analysed information for eyeliner tattoos that were more than 10 years old to ensure that the study was comparable. All eyeliner tattoos were blue–black in colour. None of the patients had previously undergone treatment for their eyeliner tattoo. Informed consent was routinely obtained prior to treatment. Patients with infections, immunodeficiency, photosensitive disorders, or a history of keloids were excluded. Pregnant women were also excluded.

As shown in Table 1, some patients were treated with a 755-nm Alexandrite picosecond laser (Picosure®, Cynosure, Boston, MA, USA), with a fluence of 1.96–6.37 J/cm^2, spot size of 2.0–3.6 mm, and pulse width of 750 ps. Other patients were treated with a 1064-nm Nd:YAG nanosecond laser (MedLite® C6, HOYA ConBio, Fremont, CA, USA), with a fluence of 2.80–7.00 J/cm^2, spot size of 3 mm, and pulse width of 5–20 ns. The clinical threshold was defined as epidermal whitening and minimal pinpoint bleeding. After each treatment session, patients were advised to apply topical antibiotic ointment twice for 1 week. The interval of treatment or follow-up was 4–8 weeks. All analysed patients completed at least one treatment and follow-up.

Clinical response was assessed by two independent physicians using digital photographs taken at the same background, luminance, and distance at each follow-up visit. The tattoo clearance rate was evaluated using a quartile grading system:

CONTACT Tong Lin ddlin@hotmail.com Department of Cosmetic Laser Surgery, Hospital of Dermatology, 12 Jiang-wang-miao Street, Nanjing, Jiangsu, China 210042; Qiuju Wu wqj0528@163.com Department of Cosmetic Laser Surgery, Hospital of Dermatology, 12 Jiang-wang-miao Street, Nanjing, Jiangsu, China 210042.

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Table 1. Laser parameters used in our study.

Parameter	Alexandrite laser	Nd:YAG laser
Wavelength (nm)	755	1064
Pulse width	750 ps	5–20 ns
Mean spot size (mm)	2.65 ± 0.30	3
Spot size range (mm)	2.0–3.6	3
Mean fluence (J/cm^2)	3.75 ± 0.81	3.87 ± 1.00
Fluence range (J/cm^2)	1.96–6.37	2.80–7.00

Table 3. Comparison of the two lasers in achieving an excellent response (grade 4).

Parameter	Alexandrite laser	Nd:YAG laser
Total no. of treated people achieved excellent response	19	13
Mean number of treatment	1.58 ± 0.77	1.85 ± 0.69
p* value	0.322	

*Significant level was defined as $p < 0.05$.

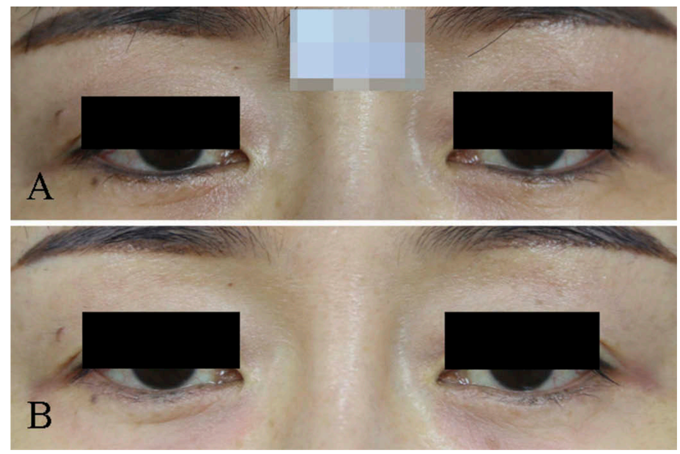

Figure 1. Eyeliner tattoo prior to the Alexandrite picosecond laser treatment (A); excellent lesion clearance (grade 4) after one treatment session (B).

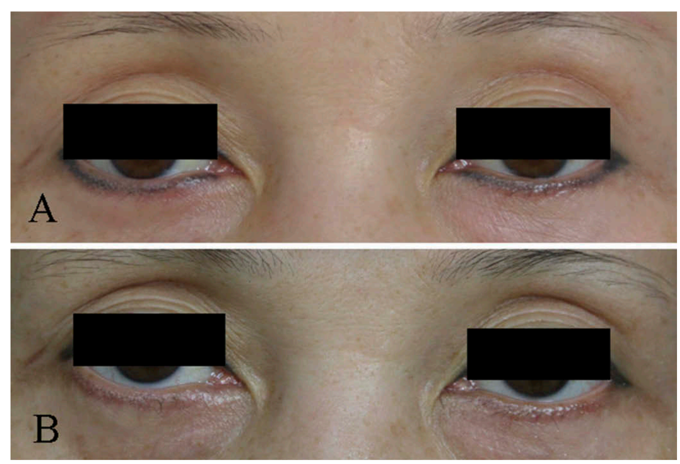

Figure 2. Eyeliner tattoo prior to the Nd:YAG nanosecond laser treatment (A); excellent lesion clearance (grade 4) after one treatment session (B).

poor response (grade 1 = 0–25%), moderate response (grade 2 = 26–50%), good response (grade 3 = 51–75%), and excellent response (grade 4 = 76–100%). The adverse effects were recorded.

Data were analysed by SPSS 17.0. The Mann-Whitney *U* test was used to compare the treatment efficacy after one session, and an independent-sample *t* test was used to compare the treatment times in patients who achieved an excellent response. $p < 0.05$ was considered statistically significant.

Results

There were 72 patients (all women) with eyeliner tattoos who were analysed in our study. The age of all tattoos included was more than 10 years. The median number of treatment was 1 (range, 1–4). In total, 51 people were treated once, 18 people were treated twice, 2 people were treated 3 times, and 1 person was treated 4 times.

Among them, 40 patients were treated with the Alexandrite picosecond laser and the other 32 were treated with the Nd:YAG laser. The median age of patients in the two groups was 43 ± 6 years and 42 ± 4 years, respectively. The efficacy of using two lasers for one treatment is shown in Table 2. After one session, the Alexandrite picosecond laser group achieved a median clearance of grade 3 (range, 1–4) and the Nd:YAG laser group also achieved grade 3 (range, 2–4). Consequently, no difference was found between the two lasers for the eyeliner removal ($Z = 0.392$, $p = 0.695$).

Next, we compared the number of treatments required to obtain an excellent response (grade 4) for tattoo clearance in the two groups. There were 19 and 13 patients who achieved an excellent response in the Alexandrite laser and Nd:YAG laser group (Table 3), with the mean number of treatments was 1.58 ± 0.77 and 1.85 ± 0.69, respectively. Although the number of Alexandrite laser group was slightly less than that of the Nd:YAG group, however, there was still no difference between the two groups ($p = 0.322$). Figures 1 and 2 showed the excellent response in two groups.

As the eyelid region is sensitive, the painfulness of using two lasers was obvious immediately after the session, but was relieved within 24 h. Although temporary adverse reactions, such as erythema, eyelid oedema, and crusting, were common after both laser treatments, they usually resolved spontaneously within 1 week. Neither group had significant adverse reactions, such as hyperpigmentation, hypopigmentation, or scarring.

Table 2. Comparison of the two lasers after one treatment.

Parameter	Alexandrite laser	Nd:YAG laser
Total no. of treated people	40	32
Grade 1 (poor)	4 (10%)	0 (0%)
Grade 2 (moderate)	6 (15%)	7 (21.9%)
Grade 3 (good)	20 (50%)	21 (65.6%)
Grade 4 (excellent)	10 (25%)	4 (12.5%)
z	0.392	
p* value	0.695	

*Significant level was defined as $p < 0.05$.

Discussion

Cosmetic tattoos, known as permanent makeup, are increasing as individuals opt to tattoo eyeliners and eyebrows for convenience (5). As a result, people frequently need to remove unwanted cosmetic tattoos by lasers, such as eyeliner tattoos. Based on theoretical models of selective photothermolysis and many clinical studies (6), very short laser pulses (ps) are more effective than longer nanosecond pulses for tattoo clearance. Therefore, picosecond lasers have recently emerged at the forefront of laser tattoo removal (7).

To date, there are many published studies which show the benefits of picosecond lasers in tattoo removal, going back to 1998 (8). The advantages of the picosecond laser are reflected in two aspects (9–12): One is that there are fewer treatment sessions and less time is required for complete tattoo removal by picosecond lasers. In addition, picosecond lasers achieve better clearance of colour tattoos, especially blue, green, and yellow, and reduce tattoo ghosting that remains after multiple sessions with nanosecond lasers. However, most clinical studies had no nanosecond control groups, and the authors generally used historical controls or previous publications to assess the efficacy of the picoseconds laser devices.

There have been a few studies that simultaneously compared the effects of picosecond and nanosecond lasers (8,13–15). Ross *et al.* (8) first described a comparable study in which 16 patients with black tattoos were treated with 10 ns pulses and 35 ps pulses from an Nd:YAG laser. The picosecond pulses achieved a significantly greater improvement in lightening black tattoos in 12 of 16 patients after four treatments. Izikson L *et al.* (13) evaluated the efficacy of a 758-nm 500 ps laser and a 755-nm 30–50 ns laser for carbon and iron oxide tattoo removal in a pig model. After a single treatment, picosecond laser produced a significantly greater degree of carbon tattoo clearance. However, it had no advantage in the treatment of iron oxide tattoos. Besides, it is important to note that the tattoos on pig skin were only 6 weeks old. Another study by Pinto *et al.* (14) compared the efficacy of an Nd:YAG picoseconds laser (450 ps) and Nd:YAG nanosecond laser (5 ns) in black tattoo removal. After two treatments, the use of ps pulses does not provide better clearance than ns pulses, but has a significantly lower degree of painfulness than the nanosecond laser. Recently, Lorgeou A *et al.* (15) reported a large prospective study on different types of tattoos treated with a Q-switched nanosecond laser compared with two types of picoseconds lasers using up to 4 laser sessions. As a result, picosecond lasers were superior to the nanosecond laser for professional tattoos. However, no difference was observed for cosmetic and amateur tattoos. According to these studies, the difference between the two types of laser for tattoo removal is still needed to be further studied, and the results might be influenced by the tattoo's age, type, and the number of treatments.

In this study, we retrospectively evaluated the efficacy of two laser treatments for eyeliner tattoos. The results show that there is no statistically significant difference between the Alexandrite picoseconds laser (750 ps) and Nd:YAG nanosecond laser (5–20 ns) for removing eyeliner tattoos which are over 10 years old. To reduce the influencing factors of treatment, we limited the age of the tattoos of two groups. In general, tattoo ink is injected into the upper part of the dermis, when applying a tattoo. The tattoo ink particles gradually move to the deeper layers of the dermis as the age of the tattoo increases, and the pigment particle concentration is significantly reduced in skin due to lymphatic transportation (16). In our research, the age of all eyeliner tattoos is over 10 years and this type of tattoo is relatively easy to be removed by lasers. Maybe more recently, applied tattoos will give us a different result between these two lasers. In addition, the wavelengths of lasers used in our study were different and might affect the comparisons of two types of lasers. And we mainly analysed the therapeutic effect of a single treatment. As the number of treatment increases, the results may be changed. All of these possibilities might need to be evaluated in future studies.

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Declaration of interest

The authors have no conflicts of interest to declare.

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