Q-switched alexandrite laser treatment (755 nm) of professional and amateur tattoos

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Background: Several laser techniques have been proposed for the removal of decorative tattoos. The lasers that have been used most successfully are Q-switched red or near-infrared systems because of their ability to target tattoo pigment selectively with minimal risk of scarring or permanent pigmentedary changes.

Objectives: The objectives of this study were to determine the clinical effectiveness of the newest Q-switched system, the alexandrite laser, in removing amateur and professional tattoos and to observe side effects.

Methods: Twenty-four multicolored professional tattoos and 18 blue-black amateur tattoos were treated with the Q-switched alexandrite laser (755 nm, 100 ns) at 2-month intervals until total clearing was achieved. The 510 nm pulsed dye laser was used to treat tattoos that contained red pigment.

Results: Professional tattoos required an average of 8.5 alexandrite laser treatments for total clearance, whereas only 4.6 treatments were necessary to remove amateur tattoos. Red tattoo pigment was successfully treated with an average of two 510 nm pulsed dye laser sessions. No scarring or long-standing pigmentedary changes were seen in laser-irradiated skin.

Conclusion: The Q-switched alexandrite laser is highly effective in removing multicolored professional and amateur tattoos without adverse sequelae. The 510 nm pulsed dye laser was useful in eliminating red tattoo pigment.


Requests for the removal of decorative tattoos are growing more numerous as the number of persons with tattoos increases. It is estimated that approximately 5% of the North American population has at least one tattoo. Numerous treatments such as surgical excision,1-3 dermabrasion,4-8 chemical therapy,9,11 cryosurgery,12 and electrocautery13,14 have been used, but each technique was limited by undesirable scarring or pigmentedary alterations.

Many laser treatments have been introduced in recent years. The earlier laser systems had less specificity and, therefore, more side effects than the latest technologic advances.14-20 The newest Q-switched laser systems, including the ruby,21-26 Nd:YAG26,27 and alexandrite,28 have shown the greatest promise in treating tattoos because of their ability to preferentially injure structures in the dermis that contain pigment with brief, selectively absorbed laser pulses. This process is termed "selective photothermolysis."29,30 Even with their increased selectivity, however, the current Q-switched ruby and Nd:YAG laser systems cannot effectively remove red and green tattoo pigments, respectively.21,27 In contrast, the Q-switched alexandrite laser is accompanied by a 510 nm pulsed dye system, which, when used in combination, could conceivably eliminate all pigment in a multicolored tattoo.

Clinical reports of the response of tattoos to the Q-switched alexandrite laser have been sparse. This study was undertaken to evaluate the clinical effectiveness of the Q-switched alexandrite laser in eliminating amateur and multicolored professional tattoos. In tattoos that contained red pigment granules, the 510 nm pulsed dye laser was also used.

MATERIAL AND METHODS

Patients who were willing to enter the study and schedule appointments every 6 to 8 weeks were recruited during a 3-month period and treated during the next 12 to 18 months. None of the patients had received any prior treatment for removal of their tattoos.
Fig. 1. Professional tattoo with blue-black and red pigments before treatment (A), immediately after alexandrite laser treatment at 6.0 J/cm² with characteristic tissue whitening (B), 6 weeks after the fourth alexandrite laser treatment (C), and 8 weeks after nine alexandrite laser treatments (mean fluence, 6.75 J/cm²) and two 510 nm pulsed dye laser treatments (mean fluence, 3.0 J/cm²) (D). Ability to tan was not affected by laser treatment.

A Q-switched alexandrite laser (Candela Laser Corp., Wayland, Mass.) with a 755 nm wavelength, 100 nsec pulse duration, and 3 mm spot size was used. After informed consent was obtained, a total of 31 patients (19 men and 12 women, ages 18 to 56 years) with 42 tattoos (24 professional and 18 amateur) were treated at 6- to 8-week intervals. At each visit the tattoo was completely covered with adjacent, nonoverlapping laser pulses at energy densities that ranged from 4.75 to 8.0 J/cm². The energy fluence used was determined by each patient's threshold response as indicated by characteristic tis-
Table I. Tattoo characteristics

<table>
<thead>
<tr>
<th>Type and location</th>
<th>No. of lesions</th>
<th>Average size (cm²)</th>
<th>Average duration (yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amateur</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Face</td>
<td>1</td>
<td>8</td>
<td>27</td>
</tr>
<tr>
<td>Chest</td>
<td>1</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>Forearm</td>
<td>11</td>
<td>18 (2-36)</td>
<td>18 (8-30)</td>
</tr>
<tr>
<td>Hand</td>
<td>4</td>
<td>5 (2-12)</td>
<td>19 (7-33)</td>
</tr>
<tr>
<td>Ankle</td>
<td>1</td>
<td>48</td>
<td>1</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>18</td>
<td>16 (2-48)</td>
<td>17.5 (1-33)</td>
</tr>
<tr>
<td>Professional</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chest</td>
<td>2</td>
<td>54 (36-72)</td>
<td>11 (4-16)</td>
</tr>
<tr>
<td>Scapula</td>
<td>5</td>
<td>56 (40-64)</td>
<td>10 (2-14)</td>
</tr>
<tr>
<td>Deltoid</td>
<td>10</td>
<td>87 (9-200)</td>
<td>19 (1-39)</td>
</tr>
<tr>
<td>Forearm</td>
<td>6</td>
<td>56 (16-140)</td>
<td>20 (8-37)</td>
</tr>
<tr>
<td>Ankle</td>
<td>1</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>24</td>
<td>66 (4-200)</td>
<td>16.0 (1-37)</td>
</tr>
<tr>
<td><strong>Total/mean</strong></td>
<td>42</td>
<td>44.5</td>
<td>16.5</td>
</tr>
</tbody>
</table>

Numbers in parentheses represent ranges.

Table II. Response of tattoos to alexandrite laser (755 nm, 100 nsec) and pulsed dye laser (510 nm, 300 nsec)

<table>
<thead>
<tr>
<th>Tattoo type</th>
<th>No. of lesions</th>
<th>No. of treatments</th>
<th>Energy (J/cm²)</th>
<th>No. of treatments</th>
<th>Energy (J/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amateur</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black-blue</td>
<td>18</td>
<td>2-9 (4.6)</td>
<td>4.75-7.5 (6.25)</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Professional</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blue-black only</td>
<td>10</td>
<td>6-13 (8.4)</td>
<td>5.75-8 (6.5)</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>+ Green</td>
<td>6</td>
<td>6-12 (7.3)</td>
<td>5.5-8 (6.79)</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>+ Red</td>
<td>5</td>
<td>6-12 (9.2)</td>
<td>5.5-8 (6.85)</td>
<td>1-3 (2)</td>
<td>2.5-3.5 (3)</td>
</tr>
<tr>
<td>+ Green and red</td>
<td>3</td>
<td>8-13 (10)</td>
<td>5.75-8 (6.75)</td>
<td>2-3 (2.3)</td>
<td>2.75-3.75 (3.85)</td>
</tr>
<tr>
<td><strong>Subtotal/mean</strong></td>
<td>24</td>
<td>6-13 (8.5)</td>
<td>5.5-8 (6.75)</td>
<td>1-3 (2.1)</td>
<td>2.5-3.75 (3.1)</td>
</tr>
</tbody>
</table>

Numbers in parentheses represent means.

Sue whitening. The energy density was reduced if an excessive response such as bleeding or tissue splatter was encountered. In the eight professional tattoos that contained red pigment, a 510 nm, 300 nsec pulsed dye laser (Candela Laser Corp.) with a 5 mm spot size was used in these areas.

No intracutaneous or topical anesthesia was used. Care after laser treatment consisted of twice-daily cleansing with mild soap and water followed by application of a topical antibiotic ointment and a non-stick bandage.

Photographs of the tattoos were taken before each laser session by one photographer who used identical lighting, camera settings, and film processing techniques. Although the photographs were used to document each patient's progress, individual responses to treatment were determined by clinical examination at each visit. Tattoos were considered to be completely cleared when the color within a laser-treated tattoo was found to be indistinguishable from the surrounding normal (or untreated) skin by two independent observers. Particular attention was paid to pigmentary and textural changes and scarring within the laser-treated site.

RESULTS

The total elimination of all tattoos in the study was accomplished with use of the Q-switched alexandrite laser. The number of laser treatments necessary ranged from 2 to 13, depending on whether
Fig. 2. Amateur tattoo before (A) and 6 weeks after (B) four Q-switched alexandrite laser treatments at a mean fluence of 6.25 J/cm².

the tattoo was an amateur or professional tattoo. On average, amateur tattoos were smaller (16 cm² vs 66 cm²) and required fewer laser treatments (4.6 vs 8.5) and lower energy densities (6.25 J/cm² vs 6.75 J/cm²) than professional tattoos (Fig. 1, A-D, Fig. 2, A and B, and Tables I and II).

No significant difference existed in the number of treatments necessary to treat professional tattoos that contained green pigment and those that contained only blue-black pigment. Tattoos that contained red pigment required an average of two treatments with the 510 nm pulsed dye laser in addition to the alexandrite laser treatments (Fig. 3, Table II).

The mean ages of the amateur and professional tattoos included in the study did not differ significantly enough to permit assessment of any differences in their response to laser treatment (Table I). In general, however, it was noted that the younger or newer tattoos required more laser treatments.

Fig. 3. Multicolored professional tattoo before (A) and 8 weeks after (B) 12 alexandrite treatments (mean fluence, 7.0 J/cm²) and three pulsed dye laser treatments (mean fluence, 3.0 J/cm²). No pigmentary alteration or scarring was noted.

This was especially true for the professional tattoos that contained newer organometallic pigments.

No adverse responses were observed in any of the laser-treated tattoos, including scarring or textural changes. Transient hypopigmentation, which was seen in two professional tattoos, completely resolved within 3 months after cessation of laser treatment.

DISCUSSION

To remove tattoo pigment completely with any of the available Q-switched laser systems, a series of repeated treatments is necessary. Each successive treatment allows continued removal of remaining pigment in a "layered" fashion. Laser treatments should be spaced at 1 to 2 month intervals to allow appropriate dermal healing, including phagocytosis of tattoo fragments. However, the ultimate fate of tattoo particles after laser irradiation remains unknown.

The results obtained with the alexandrite laser in this study (Tables I and II) demonstrate high tattoo pigment selectivity and are in keeping with results obtained with the Q-switched ruby and Nd:YAG lasers. Removal of amateur tattoos required a mean of 4.6 alexandrite laser treatments, and elimination of professional tattoos required a mean of 8.5 treatments. The increased number of treatments required for professional tattoos has been attributed to the increased pigment content and to the organometallic dyes used.

It is important that even green and red tattoo pig-
ments can be removed with the combination of alexandrite and 510 nm pulsed dye lasers, because other Q-switched lasers do not have this capacity. Approximately one quarter to one third of professional tattoos contain green and/or red pigment that cannot be eliminated by the Nd:YAG and ruby lasers, respectively.

The results of this study illustrated several other advantages of the Q-switched alexandrite laser compared with other Q-switched lasers. First, no long-term pigmented changes were encountered; these changes are common after ruby laser treatment. The slightly longer wavelength of the alexandrite laser allows less melanin absorption and deeper tissue penetration, thereby reducing pigmentary changes and increased absorption by dermal tattoo pigment. Second, no tissue splatter is encountered with the alexandrite laser. In general, much higher energy densities (on the order of 8 to 10 J/cm²) are required to effect the desired degree of tattoo lightening by the Nd:YAG and ruby lasers. The increased fluences and smaller spot sizes used in Nd:YAG laser treatment, in particular, are responsible for the prominent bleeding and tissue splatter associated with its use. The energies used in this study (average, 6.5 J/cm²) produced excellent clinical responses without the risks inherent with tissue debris exposure. Lastly, the features of the alexandrite laser allow rapid treatment sessions with minimal discomfort, thereby eliminating the need for anesthesia, which is commonly used with other Q-switched laser systems.

REFERENCES