Treatment of Tattoos with Single and Double-Pulse Q-Switched Alexandrite Laser

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Abstract

Background: Q-Switched lasers have proven effective for treatment of tattoos with a low probability of scarring. However, the treatment course is tedious with professional tattoos often requiring six or more treatments to achieve acceptable lightening. In an effort to improve clinical efficacy, a novel Q-switched pulse format was developed to introduce two Q-switched pulses to target tissue within the inertial confinement time of tissue, and allowing up to 2x the delivered fluence per treatment pulse. A study was undertaken to evaluate the tissue effects and possible benefits of this pulse format.

Methods: A total of 10 subjects presenting with three sites with blue, black, and/or green tattoos were enrolled in the study. Each tattoo was divided into three areas, labeled and photographed. One area was treated using a single 60-nsec pulse format, with a 3-mm handpiece treating at 5Hz and at a fluence of 5 j/cm². The other two areas were treated using a double pulse format consisting of two 60-nsec pulses separated by a 70-ns inter-pulse-interval, using a 3-mm handpiece at 10 j/cm² and using a 5-mm handpiece at 5j/cm². Re-treatment was done at 6-12 week intervals. All treatments were done using an Accolade Q-switched alexandrite laser (Accolade, Cynosure, Inc.).

Results: Both single and double-pulse treatments resulted in significant lightening of tattoos. Tattoos treated with the double-pulse format achieved greater, or acceptable lightening in fewer treatments than the single-pulse treated side. There were no significant side effects noted in either case. Enhancement in tattoo removal is likely due to the increased fluence delivered on target in a given treatment with double pulse format, by the use of a larger spot size, or a combination of both.

Background

Q-switched Alexandrite lasers have been employed for lightening or eliminating tattoos for over ten years. They have proved effective, particularly for treatment of black, brown, and green tattoo inks. The longer pulse duration of the alexandrite laser appears to provide some clinical benefit over Nd:YAG and Ruby lasers, producing less bleeding. Still, these lasers often require 8 or more treatments to effects successful treatment of a tattoo.

The proposed mechanism of action for Q-switched lasers has been postulated as primarily due to the shock wave absorption and conversion to heat. However, recent studies have suggested that a thermal mechanism may participate in treatment of tattoos, as well. Assuming the shock-wave hypothesis, an evaluation of the mechanics of shock-wave creation and propagation found that while the shock-wave propagates at super-sonic speeds, tissue inertia limits the rate of tissue movement, such that tissue is effectively confused (doesn’t move) for more than 100 usec following shock-wave induction. Thus, no tissue effects, including tissue frosting associated with cavitation, are manifested for approximately 100 usec following laser exposure.

To take advantage of this tissue behavior, a novel pulse format was developed which allows additional energy, up to a total of double that in a single pulse, to be pumped into the tissue prior to the initiation of cavitation. This format provides two, 60-nsec pulse-lets within 70-ns, while tissue remains transparent to laser energy [Figure 1].

The goal of this study was to determine the utility of this format in the treatment of tattoos, and to determine if there are any advantages to this format.

Methods

A total of 10 subjects presenting with three sites of blue, black, and/or green tattoos were enrolled in the study. To be enrolled in the study, tattoos needed to be untreated and subjects with conditions for which laser therapy was contraindicated were excluded from the study.

Each tattoo was divided into three areas of approximately equal color and pigment concentration [Figure 2], labeled and photographed before and immediately following treatment. Prior to treatment, topical anesthetic was applied, as appropriate for treatment comfort.

All treatments were done using an Accolade Q-switched alexandrite laser (Accolade, Cynosure, Inc.). One area was treated using a single 60-nsec pulse format, with a 3-mm handpiece treating at 5Hz and at a fluence of 5 j/cm². The other two areas were treated using a double pulse format consisting of two 60-nsec pulses separated by a 70-ns inter-pulse-interval, using a 3-mm handpiece at 10 j/cm² and using a 5-mm handpiece at 5j/cm². Re-treatment was done at 6-12 week intervals. Subjects were treated up to a total of three times during the course of the study, and complete tattoo clearance was not achieved in most cases.

Photographs were taken one month following the final procedure. A photographic comparison was then done, comparing between treatment settings and comparing before and after photographs to determine effects of treatment and possible advantages and disadvantages of treatment.

Results

Results of this study were rather surprising. The degree of clearance of tattoo pigment appears to be independent of both treatment fluence and number of treatments. The immediate effects of the three treatment parameters are evident. In each case, single pulse treatments caused immediate whitening of treatment area to a degree which correlated approximately with fluence [Figures 2,3]. There were no cases of significant splatter or bleeding. High fluence treatment was associated with persistent redness [Figure 2C]. Treatment with the 5-mm handpiece using double-pulse format exhibited a different response ranging from erythema and generalized urticarial response [Figure 2H] to mild tissue whitening [Figure 3B].

These results suggest that in some subjects, and at least for the early stages of tattoo treatment, the new pulse configuration, possibly combined with the capability to treat with a larger spot size provide a therapeutic advantage. Further, these results suggest that tattoo treatment may not embody a simple photo-acoustic effect, but may engender a complex response including photo-thermal, auto-immune, and wound healing elements.

Further investigation into the underlying mechanism of action is recommend to further elucidate this mechanism and take advantage of the therapeutic outcome of these studies.

Discussion

Results of this study were rather surprising. The degree of clearance of tattoo pigment appears to be independent of both treatment fluence and observed tissue response.

These results suggest that in some subjects, and at least for the early stages of tattoo treatment the new pulse configuration, possibly combined with the capability to treat with a larger spot size provide a therapeutic advantage.

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References

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