ISSN 1855-9913

Journal of the Laser and Health Academy
Vol. 2013, No.1; www.laserandhealth.com

1064 nm Q-Switched Photo-Acoustic Laser Ablation of Xanthelasma Palpebrarum

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ABSTRACT

Xanthelasma palpebrarum is the most common xanthomatous lesion of the skin and a common persisting cutaneous condition involving delicate peri-ocular regions. Currently there are several ablative and non-ablative treatments available with various degrees of effectiveness. Preliminary studies using 1064 nm Q-Switched Nd:YAG laser have shown promising results of xanthelasma treatment when high intensities were used. To assess the safety and efficacy of a single session of 1064 nm Q-Switched Photo-Acoustic Laser Ablation on xanthelasmas, twelve Fitzpatrick II–III patients with 20 palpebral lesions were included in the study. All patients completed their post-operative clinical evaluation by two different dermatologists. The results after 1064 nm Q-S laser treatment were rated from good to excellent in all patients. The moderate swelling observed immediately after treatment was cleared after 5 to 7 days, and 120 days after the procedure no scars were observed.

The 1064 nm Q-Switched laser was therefore regarded as a safe and effective solution to treat xanthelasma palpebrarum when photo-acoustic ablative parameters are used.

Key words: Q-Switched Nd:YAG, laser treatment, photo-acoustic effect, xanthelasma palpebrarum

Article: J. LA&HA, Vol. 2013, No.1; pp. 48-51.
Received: May 6, 2013; Accepted: June 10, 2013.

I. INTRODUCTION

Xanthelasma Palpebrarum, which is characterized by yellowish plaques on or around the eyelids, is the most common xanthomatous lesion of the skin. They are composed of xanthoma cells, the foamy lipid-laden histiocytes, primarily within the upper reticular dermis.

The main lipid that is stored in histiocytes is esterified cholesterol. Xanthelasmas affect less than one percent of the population, but they are more often observed in women than in men (approximately 3-fold), and their prevalence increases with age. They are linked with hyperlipidemia in about 50% of cases [1].

Currently there are various options to treat xanthelasma, however treating *xanthelasma palpebrarum* may be challenging because of its delicate location on eyelid regions. Traditional treatment of xanthelasma is based on surgical excision of relevant and clinically evident plaques. Possible risks related to surgical procedures performed on delicate peri-ocular regions as well as a relatively high percentage of local recurrence of xanthelasmas has led physicians to explore alternative treatments such as cryotherapy, electrodessication and chemical peeling [2].

Medical literature reports effective use of carbon dioxide and Er:YAG lasers in the treatment of periocular xanthelasmas [3–8]. With CO_2 lasers, the lesions can be photothermally removed, but substantial risks of scarring and post-inflammatory hyperpigmentation should be considered [6]. Alternatively, Er:YAG lasers allow precise microthermal tissue ablation in delicate anatomical locations with excellent control of penetration depth. Post-treatment side effects are therefore minimized due to extremely well-modulated photo-thermal laser effects [7]. With the aim of reducing side effects and potential untoward clinical results as observed in conventional treatments, non-ablative laser technologies have been considered as possible alternatives [9–15]. Argon lasers and pulsed dye lasers are limited by insufficient penetration depths to effectively treat periocular xanthelasmas [11,16,17]. Additionally, frequent recurrence and potential scarring have significantly limited argon laser use as a therapeutic option to treat xanthelasmas [16,17].

Recent studies focusing on 1064 nm Q-switched Nd:YAG laser treatment of xanthelasmas have shown controversial results. A study performed by Fusade [13] demonstrated the potential benefits of 1064 nm Q-switched Nd:YAG lasers in eradicating xanthelasma, however, studies by Karsai et al. [14] and Kaliyadan and Dharmaratnam [15] were not able to reproduce comparable clinical results.

In this study we wanted to further evaluate the safety and efficacy of single-treatment sessions of 1064 nm Q-switched Nd:YAG photo-acoustic laser ablation for Xanthelasma treatment.

II. MATERIALS AND METHODS

Twelve patients aged 33-54 (mean 45) with Fitzpatrick skin types II to III and 20 periocular xanthelasmas were included in the study. Twelve lesions were never treated before and eight were recurrent after different previous treatments.

Before participating in the study, patients were informed about potential risks and benefits, including potential complications related to 1064 nm Q-S laser ablation. Proper informed consents were signed by all participants. The study was performed according to principles of good clinical practice and the Declaration of Helsinki. Eye protection was provided by metal corneal eyeshields (COX II – Durette, Canada) (Fig.1). During Q-S laser procedures, the affected palpebral skin was constantly stretched to "move" xanthelasmas as far as possible from eye bulbs.

Fig. 1: Eye protection with metal laser-proof corneal eye-shields.

Each patient received a single treatment on each xanthelasma with a 1064 nm Q-S laser (QX Max system – Fotona, Slovenia) with fluences sufficient to generate a visible ablative photo-acoustic effect (pinpoint bleeding). An average fluence of 12 J/cm^2 with 2 mm spot and frequency of 10 Hz were used according to a multiple-stacking-pass technique. The treatment endpoint was set at almost complete ablation of visible dermal cholesterol-laden tissue. Feathering was performed at the periphery of all treated sites. Post-operative care consisted of the application of wet compresses with a 0.9% sodium chloride (NaCl) solution followed by sterile petrolatum until complete re-epithelization was achieved.

Serial standardized digital photographs taken pre-operatively and also 42 and 120 days post-operatively were assessed by two independent dermatologists. Treatment efficacy was graded on a 5 point scale: 0 – no improvement; 1 – minor (1–25% clearing); 2 – fair (26–50% clearing); 3 – good (51–75% clearing); 4 – excellent (76–100% clearing). Safety evaluation included clinical assessment of dyspigmentation and scarring.

The patients' subjective assessments regarding treatment outcome and willingness to repeat the procedure in case of recurrence were also obtained.

III. RESULTS

All subjects completed their post-operative clinical examination by two independent dermatologists. Clinical improvement was evaluated as good (51–75%) in 6 lesions to excellent (76–100%) in 14 lesions with an excellent interrated observer's reliability (~90%) (Fig. 2).

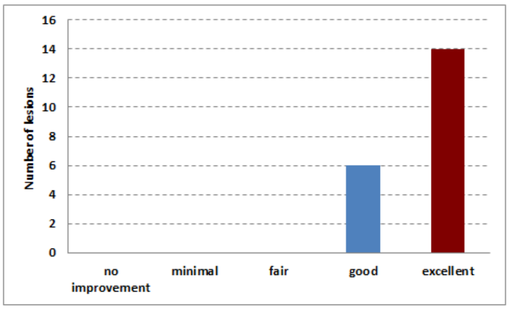

Fig. 2: Overall clinical improvement assessed by two independent professional observers. 0 = no improvement, 1 = minimal (1–25% clearance), 2 = fair (26–50% clearance), 3 = good (51–75% clearance), 4 = excellent (76–100% clearance).

Photographic samples of the treatment results are shown in Figs. 3 to 5. All treatments induced purpuric discoloration peripherally to the ablated areas and moderate swelling lasting from 5 to 7 days.

Fig. 3: a) Patient 1 with xanthelasma on lower eyelid b) immediately after c) and 42 days after Q-S 1064 nm laser photo-acoustic ablation

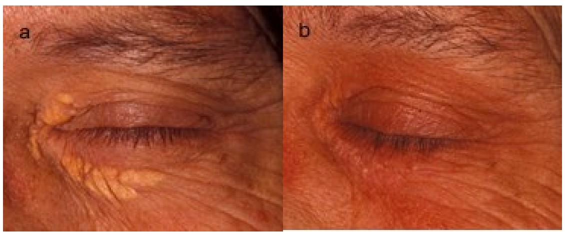

Fig. 4: Patient 2 with xanthelasma on both eyelids before (a) and 120 days after 1064 nm Q-S laser treatment (b).

Fig. 5: Patient 3 with xanthelasma on upper eyelid before (a) and 120 days after Q-S 1064 nm laser photo-acoustic ablation (b).

Except for mild post-inflammatory hyperpigmentation in two lesions (10%), subsequently reported spontaneously fading 120 days after the laser procedure, no major side effects such as scars or major textural changes were observed. All treatments were performed under local anesthesia (infiltration) and were reported to be well tolerated. All patients reported minimal or no post-operative pain and patient satisfaction was high except for the two patients who developed a post-inflammatory hyperpigmentation (Fig. 6).

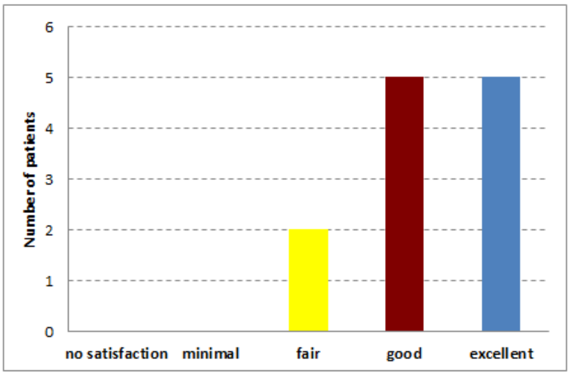

Fig. 6: Patient's assessment of satisfaction with the Q-S laser treatment. 0 = no satisfaction, 1 = minimal satisfaction, 2 = fair satisfaction, 3 = good satisfaction, 4 = excellent satisfaction.

IV. DISCUSSION

1064 nm Q-Switched Nd:YAG laser therapy is already a well established treatment modality for many of the most common pigmentary skin alterations such as nevus of Ota, solar lentigos and superficial melasma, besides being considered the gold standard procedure for tattoo removal [18–21].

In vitro measurement of human fat absorption spectra have identified promising bands near 1210 and 1720 nm [22] and have shown that fat tissue can be selectively and efficiently targeted with laser light of 1064 nm [23]. Further, laser lipolysis by 1064 nm Nd:YAG laser has shown to be a very safe and effective procedure leading to good and reproducible clinical results [24]. Since xanthelasmas are defined as lipid-laden intradermal plaques, previously reported studies suggest that 1064 Nd:YAG laser could be effective also for xanthelasma treatment.

In our study we evaluated the effectiveness of 1064 nm Q-Switched photo-acoustic laser ablation on a series of xanthelasma palpebrarum and our results confirmed that this innovative treatment can be considered as a safe, effective treatment modality as proven by clinical improvements observed in all tested patients by two independent observers.

In the study performed by Fusade, clinical results observed in eight out of eleven patients treated with 1064 nm Q-S laser ablative technique were rated good-to-excellent after a single session [13]. Karsai *et al.* [14] and a case report presented by Kaliyadan and Dharmaratnam [15] could not confirm similar positive results, suggesting additional studies should have been performed to confirm 1064 nm Q-switched Nd:YAG laser photo-ablation as a suitable treatment to eradicate xanthelasma palpebrarum. Conflicting results of Q-switched Nd:YAG laser therapy on xanthelasmas may be justified by different treatment parameters used by different authors. In our personal experience proper selection of relatively "aggressive" treatment parameters are essential for a positive outcome. In all previous studies, non-ablative parameters were used with fluences between 4 and 8 J/cm^2 with an end point set at observation of pin-point bleeding [13–15]. According to our experience, these parameters may be sufficient to achieve a photo-acoustic destruction of superficial and intermediate depth esterified-cholesterol-laden hystiocytes, leaving deeper dermal cells intact or only partially affected. This observation might partially explain the disappointing results described by Karsai *et al.* [14].

In our study Q-S laser fluences sufficient to generate a visible ablative photoacoustic effect were used, with the treatment end-point set at almost complete ablation of visible dermal cholesterol-laden tissue. Our end-point parameters are thus more similar to CO_2 and Er:YAG laser photo-thermal ablation. The major advantage of the 1064 nm Q-switched Nd:YAG laser layering treatment, using 5 ns top-flat pulses, is that it allows fragmentation of target cells without induction of any significant peripheral thermal effect, therefore reducing the risk of post-inflammatory hyperpigmentation (PIH) or hypopigmentation and scarring. No major side effects such as scars and and/or major textural changes were observed in any of our 12 patients. The only side effect was a relatively short-lasting, mild hyperpigmentation which spontaneously faded 120 days after treatment. This observation, along with the remarkable clinical results, could account for such a high level of acceptance among our study patients.

V. CONCLUSIONS

The 1064 nm Q-switched laser can be considered as a safe and effective innovative solution to treat xanthelasma palpebrarum when sequentially layered photo-acoustic ablative parameters are used. Usage of 1064 nm Q-S Nd:YAG laser to treat xanthelasma palpebrarum has been shown to be associated with evident clinical benefits including drastic reduction of side-effects, like pronounced textural changes, scars, or hyperpigmentation/hypopigmentation. The treatment is extremely easy to perform and is very well accepted by patients. The combination of a highly confined, superficial micro-photo-thermal effect with deeply penetrating photo-acoustic mechanical destruction can produce biological alterations which could be unique to Q-S laser systems. This unique minimally thermal, photo-biochemical and predominantly photoacoustic laser tissue interaction could be potentially used to treat skin alterations other than xanthelasma palpebrarum. Further studies are certainly warranted to explore the many treatment possibilities offered by 1064 nm Q-Switched lasers set at photo-acoustic treatment parameters.

Acknowledgement

The author of this study did not receive any compensation for this work from any manufacturer. The loan from Fotona of a laser used in the study is gratefully acknowledged.

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