

A Prospective Split-Face Study of the Picosecond Alexandrite Laser With Specialized Lens Array for Facial Photoaging in Chinese

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ABSTRACT

Background: A 755nm picosecond alexandrite laser with a diffractive lens array has been reported for the treatment of acne scar and photoaging with clinical efficacy. In this study, we evaluated the application of the 755nm picosecond alexandrite laser with a diffractive lens array for facial photoaging in Chinese.

Materials and Methods: Ten subjects with moderate facial photoaging were enrolled in a prospective, evaluator-blinded, open-label, and split-face trial to assess the efficacy and safety of the 755nm picosecond alexandrite laser with a diffractive lens array for facial photoaging. Each subject received a series of four treatment sessions on the right side of the face at two-week intervals. The left side of the face served as the control side. Blinded evaluation of baseline, pre-treatment, and two-month follow-up visit was performed by two independent dermatologists on a 5-point global photoaging scale (GPS) and a 6/8-point Asian photographic scale (APS). Adverse events and discomfort associated with the treatment were also assessed.

Results: Significant improvement in photoaged tissue was observed on the treated side of the face, with a mean GPS score decrease from 2.67 to 1.44 at the two-month follow-up visit. A greater improvement in wrinkles was observed (2.78 vs 1.89; $P < 0.05$) when compared to the improvement in pigmentation (2.67 vs 2.11; $P < 0.05$). No changes were observed on the control side. Treatment results improved gradually throughout the treatment program and continued to the two-month follow up. In addition, skin tightening was perceived in all subjects, and shallower nasolabial folds were observed in 60% of the subjects on the treated side of face. Moderate pain and transient erythema were observed as the two main discomforts associated with the treatment.

Conclusions: The 755nm picosecond alexandrite laser with a diffractive lens array is efficacious and safe for rejuvenation of photodamaged facial tissue in Chinese.

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INTRODUCTION

Photoaging is a major cosmetic concern which is characterized by various cutaneous changes on sun-exposed areas induced by excessive or cumulative ultraviolet radiation.¹ These changes include irregular pigmentation, fine lines, wrinkles, keratosis, coarse skin texture, and skin tone alterations. Various treatment modalities have been introduced to address photoaging, such as lasers, chemical peels, radio-frequency, ultrasound, injections, and surgery.² Many of these invasive approaches, especially ablative lasers and surgery, are associated with an extended downtime and an increased risk of complications including dyspigmentation, skin infections and scarring. Darker skin type populations are more prone to develop post-inflammatory hyperpigmentation (PIH), limiting the use of those invasive procedures despite their enhanced clinical efficacy.³ Asians have been particularly problematic with PIH as a result of unpredictable responses to laser due to undiagnosed melanin content. As a result, non-invasive or minimally invasive approaches, such as fractional and non-ablative lasers, have been gaining in popularity due to their clinical benefit with a low occurrence of side effects.⁴⁻⁶

Q-switched laser technology has been widely used for the treatment of unwanted tattoos and benign pigmentary skin disorders.⁷ In recent years, Q-switched Nd:YAG Laser (QSNYL) toning, a noninvasive approach, has also been shown to successfully improve photoaging and acne scarring with a little or no downtime and minimal side effects.^{8,9} A new generation of technology, a picosecond-pulsed alexandrite laser (755nm), has recently been introduced for its superior effectiveness in the treatment of unwanted tattoos and various unwanted pigmentary conditions.¹⁰⁻¹³ Because of its extremely short pulse duration (hundreds of picoseconds), this novel alexandrite laser is capable of generating both photothermal and photomechanical effects on the tissue while minimizing collateral thermal damage. Combining a specialized diffractive lens array, the picosecond laser delivers intensified energy in a fractionated manner while maintaining a low total fluence, hence achieving a high safety profile. This novel non-ablative fractional resurfacing technology has been reported to be effective for acne scarring and photoaging décolletage.^{14,15} This new technology has also added a new component to traditional Q-switched

FIGURE 1. Front view of Fractional Pico Toning treatment of facial photoaging in Chinese: (A) baseline and (B) follow-up visit, showing improvement in the signs of overall photoaging and skin texture after four sessions of treatment.



laser toning by shortening the pulse to the picosecond domain. This type of treatment, called “Fractional Pico Toning” has been gaining much popularity among patients with mild-to-moderate degree of photoaging. It involves multiple passes of the diffractive lens array over the targeted tissue which helps to clear the mild-moderate photoaging as well as aid in textural improvements. There is however, only limited clinical research that had been done in Asians. The present study aims to evaluate the efficacy of the picosecond alexandrite laser with a diffractive lens array for the treatment of facial photoaging in Chinese patients.

MATERIALS AND METHODS

Subjects

This is a prospective, evaluator-blinded, open-label, split-face study conducted in compliance with the Declaration of Helsinki. Institutional Review Board (IRB) approval was granted by the local medical research ethics committee. Ten Subjects (10 females) were enrolled in this study, age 30–55, with Fitzpatrick skin type III–IV, and presenting with symmetrical evidence of facial photoaging with a baseline at least grade 2 out of a 5-point global photoaging scale described by Dover et al.¹⁶ The exclusion criteria includes a

history of resurfacing procedures within last two years, recent severe sun exposure, the use of oral retinoid or other photosensitive medications, active skin infections or inflammatory disorders, history of keloid and hypertrophic scar, severe systemic conditions, pregnancy, and lactation. Informed consents were obtained from the subjects before they were enrolled.

Study Design and Intervention

The study was designed to evaluate the efficacy of the picosecond alexandrite laser with a diffractive lens array for the treatment of facial photoaging in Chinese patients. Subjects received a total of four sessions of laser treatments at a two-week interval. Prior to each treatment session, subjects were requested to have their faces gently cleansed and patted dry. No topical anesthetic was applied. The 755nm picosecond alexandrite laser (Picosure, Cynosure, MA) with a diffractive lens array (Focus Optic) was utilized in all treatment sessions. The intervention was conducted in a split-face manner at each session: the right side of the face received treatment from the 755nm picosecond alexandrite laser with a diffractive lens array, and the left side of the face received no intervention acting

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FIGURE 2. Side view of Fractional Pico Toning-treated side of the face: (A) baseline and (B) follow-up visit.

as a control. Treatment parameters were individually adjusted according to the Fitzpatrick skin type of each subject: for those who are skin type III, a 6mm diffractive lens array with a fluence of 0.71J/cm² delivered at 2.5 to 5 Hz was used; for skin type IV patients, an 8mm diffractive lens array with a fluence of 0.4J/cm² delivered at 2.5 to 5 Hz was used. An average of 1500 pulses was delivered on the treated side of the face for each subject in one treatment session. Typically, two to three passes with a 10-20% overlap between each pulse were required to achieve the clinical endpoint of moderate erythema. Following each treatment session, a cooling mask was immediately applied to provide a soothing effect, followed by the use of moisturizer. Sun block was also advised. Subjects were followed up for two months after the completion of all four treatment sessions.

Evaluation of Efficacy and Complications

Assessment of facial photoaging was conducted by two blinded independent dermatologists who were not involved in the enrollment, treatment, or study visit. Digital photographs were taken from different angles at baseline, each treatment visit, and follow-up time points. Based on these digital photographs, severity of facial photoaging was then assessed based on two

scales, a 5-point Global Photoaging Scale (GPS) by Dover et al.¹⁶ and a 6/8-point Asian Photographic Scale (APS) described by Chuang et al.¹⁷ In addition, a 10-point Visual Analog Scale (VAS) was also used to evaluate the pain associated with the treatment immediately post treatment. Post-treatment erythema, edema, pigmentary changes, and other anticipated side effects were also documented at each visit.

Statistical Analysis

The Wilcoxon signed rank test was used to compare the scores of GPS and APS of each side of the face between baseline and 2-month follow-up visit. Meanwhile, differences of GPS on the same side of the face among all time points were determined by the Friedman test. The VAS of pain was also analyzed. Statistical analysis was conducted by IBM SPSS version 16.0 (IBM Corporation, Somers, NY). The level of significance was defined as $P < 0.05$.

RESULTS

Ten female subjects were enrolled in the study and all participated to completion. The mean age was 45.70±7.94. Five subjects were categorized as Fitzpatrick skin type III and the

FIGURE 3. Side view of the control side of the face: (A) baseline and (B) follow-up visit.

rest as Fitzpatrick skin type IV. Subjects showed a symmetrical, moderate level of baseline facial photoaging, with a mean GPS score of 2.67, and APS scores of 2.67 and 2.78 for pigmentation and wrinkles, respectively. Complicating skin conditions included melasma on three subjects and rosacea on one subjects.

Evaluation of Efficacy

After four treatments, significant improvement in photoaging was observed at two-month follow up on the treated side of the face (Figures 1 and 2) compared to the control side (Figure 3), with GPS score decrease from 2.67 to 1.44 ($P=0.005$; Table 1). More

significant improvement in wrinkles (Figure 4) was observed than that in pigmentation (Figure 5), with the APS score decrease from 2.78 to 1.89 ($P=0.005$). Treatment results improved gradually throughout the treatment regimen and achieved even better improvement at two-month follow up (Table 2). Furthermore, skin tightening was perceived in all subjects, and nasolabial folds improved in 60% of the subjects on the treated side of face.

Evaluation of Treatment-Associated Complications

Pain was the major treatment associated complication during the treatment process and was quantified immediately

TABLE 1.**Photoaging Scores of the Patients Before and After the Treatment**

Visits	Treated side			Control side (P -value)		
	GPS*	APS**		GPS*	APS**	
		Pigmentation	Wrinkle		Pigmentation	Wrinkle
Baseline	2.67±0.50	2.67±1.00	2.78±0.67	2.67±0.50	2.67±1.00	2.78±0.67
Follow-up	1.44±0.53	2.11±0.93	1.89±0.60	(0.005***)	-0.059	(0.005***)

*global photoaging scale, **Asian photographic scale, ***significance level $P<0.05$.

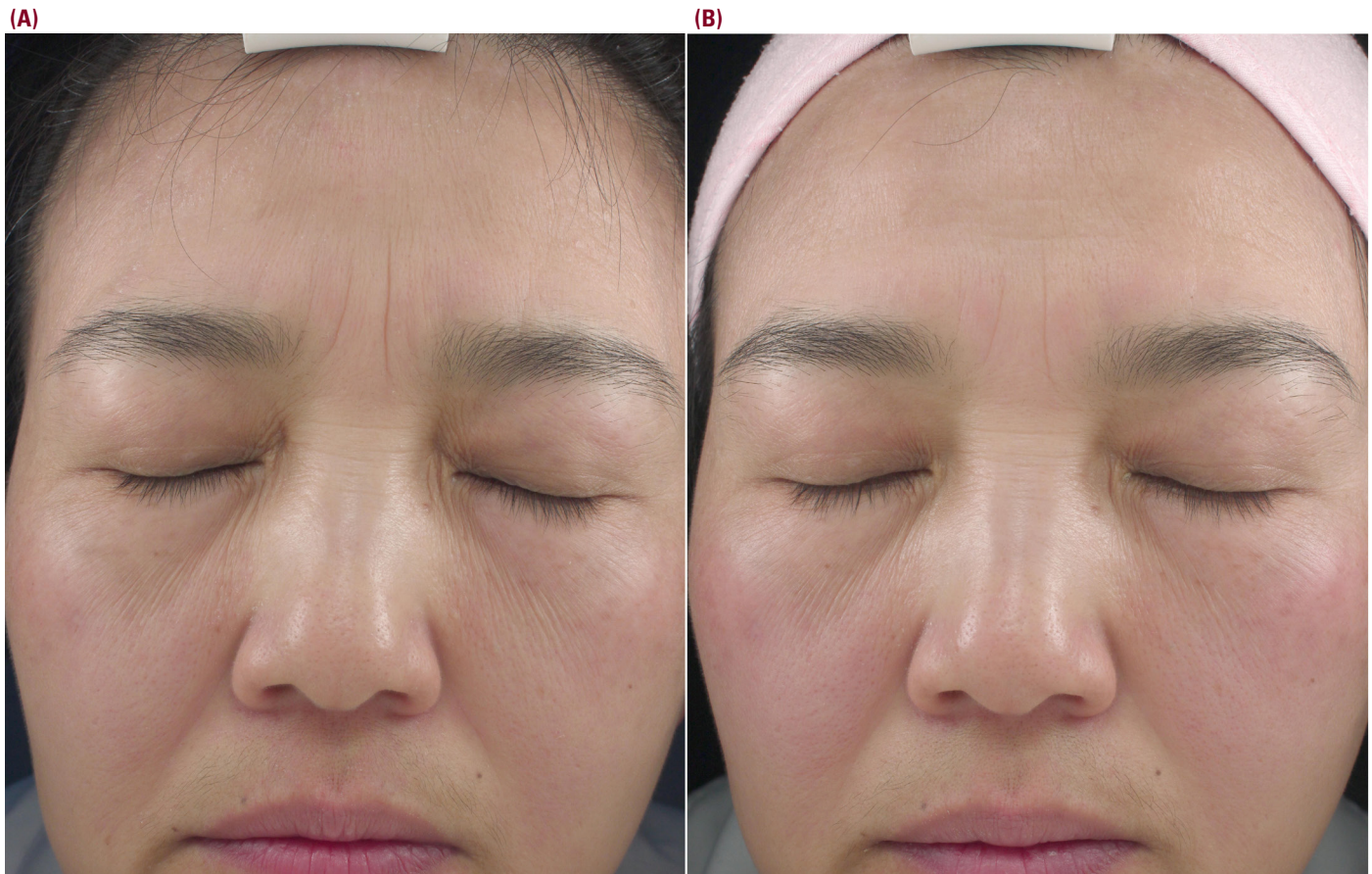
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FIGURE 4. Fractional Pico Toning treatment of wrinkles associated with facial photoaging in Chinese: (A) baseline and (B) follow-up visit, showing improvement in the wrinkles, jaw line, and slight shallowing of nasolabial fold on the treated side.



post-treatment. The mean scores of VAS for each session was 6.3, 6.9, 6.0, and 6.4 out of 10, respectively, which indicates a moderate level of pain. However, it was well tolerated by all subjects. No significant differences of pain level were found among four treatment sessions ($P=0.122$). Transient erythema was the main complication after the treatment, which normally subsided in less than 24 hours. Mild edema was seen once in one subject which resolved along with the erythema in few hours. No dyspigmentation, exfoliation, or other post-treatment discomfort was noted.

DISCUSSION

As a novel, noninvasive rejuvenation technology, 755nm pico-second alexandrite laser with diffractive lens array (Fractional PicoToning) was indicated to be efficacious for Asian facial photoaging in this prospective, split-face study. Based on the scores of Dover's and Chuang's scales, the general condition of photodamaged skin achieved significant improvement on the treated side of the face compared to the control side. These results were largely consistent with a previous study on photoaging décolletage in which texture, keratosis, and rhytides

TABLE 2.

Photoaging Scores Associated With the Number of Treatments

Scale	Baseline	After Tx1	After Tx2	After Tx3	After Tx4 (Follow-up)	P-value
GPS*	2.67±0.50	2.67±0.50	2.33±0.71	1.56±0.53	1.44±0.53	0.000***
APS**-pigmentation	2.67±1.00	2.67±1.00	2.44±0.73	2.33±0.87	2.11±0.93	0.006***
APS**-wrinkle	2.78±0.67	2.78±0.67	2.78±0.67	2.44±0.89	1.89±0.63	0.000***

*global photoaging scale, **Asian photographic scale, ***significance level $P<0.05$.

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FIGURE 5. Fractional Pico Toning treatment of pigmentations associated with facial photoaging in Chinese: (A) baseline and (B) follow-up visit, showing mild improvement in pigmentation on the treated side.



were all improved after three sessions of treatment.¹⁵ Though the treatment process was moderately painful, it was generally tolerable for most subjects with no topical anesthetic.

Among various Q-switched laser systems, Q-switched Nd:YAG Laser is the most widely used technology in aesthetic laser practice in Asia for the treatment of photoaging and melasma.^{8,18} QSNYL toning, like most other non-ablative resurfacing procedures, relies on thermal injury in the targeted tissue which induces collagen remodelling while sparing the epidermis.¹⁹ With relatively large spot sizes and low fluences, QSNYL has proved to be an effective rejuvenation modality in Asians.⁸ Dual-pulsed QSNYL, which was recently introduced may enhance its clinical efficacy.²⁰ Given that different assessment tools and study protocols were followed, it is difficult to make a direct comparison between QSNYL toning and Fractional Pico Toning. Nevertheless, the latter seems to be safer based on current clinical results.^{14,15,21} To ensure efficacy, QSNYL toning requires multiple passes / sessions or increased fluences in order to reach a clinical endpoint of pinpoint bleeding at each treatment.⁸ This may lead to a longer downtime and increased risk of

post-inflammatory dyspigmentation in Asian patients, rendering it less desirable as a noninvasive procedure. As shown in the present study, the clinical endpoint for Fractional Pico Toning, moderate erythema, was achieved through less aggressive treatment parameters than that of QSNYL toning. Furthermore, two to three passes for Fractional Pico Toning were required to achieve the desired clinical endpoint which was less than most traditional QSNYL toning needs. Thus a better safer profile can be expected. For those patients with melasma, a refractory pigmented disorder often complicating photodamaged skin in Asians, QSNYL may also exacerbate the lesion or even induce mottled hypopigmentation.²² Fractional Pico Toning, unlike QSNYL, delivers the laser energy in a fractionated manner. Using a specialized diffractive lens array, the picosecond alexandrite laser creates multiple micro-treatment zones with concentrated focal energy at approximately 15J/cm² for the 6mm spot, leading to enhanced efficacy due to high peak energy. However, only less than 10% of the skin is treated with peak fluences. The surrounding skin is exposed to much lower fluences with an average fluence of 0.71J/cm² (6mm spot) over the entire treated area, thus minimizing collateral damage to the epidermis.²¹ The

use of the diffractive lens array alone or with the flat optic can be used successfully to treat unwanted pigmentation associated with photo damage in Asians.

Apart from fractionated laser delivery, Fractional Pico Toning creates a novel injury based on the theory of laser-Induced Optical Breakdown (LIOB) for skin revitalization recently characterized by Tanghetti.²³ Using picosecond alexandrite laser pulses intensified through a diffractive lens array, LIOB is created within the epidermis which results in a localized intra-epidermal injury where the surrounding epidermal cells remain intact. LIOB subsequently triggers a healing process and collagen remodeling to aid in the resurfacing process, potentially responsible for the continuous improvement of skin texture and fine wrinkles in our subjects over time.

Secondly, after the creation of an LIOB a laser could potentially generate a pressure wave or shockwave which induces cellular changes that may ultimately result in the production of new collagen, mucin and elastic tissue. The high energy peaks of Fractional Pico Toning may also contribute to the photo-mechanical effect that is postulated. Both of these speculated mechanisms do not result in significant thermal damage. The preservation of the epidermis with this type of localized injury appears to lead to rejuvenation without a significant risk of dyspigmentation or prolonged downtime.

The present study is limited by its small sample size and a relatively short follow up. Future exploration may involve a larger sample size and direct comparisons with other non-ablative modalities, such as QSNYL toning and intense pulsed light. Using fixed spot-sizes and low fluences, the non-fractional flat optic mode of Pico Toning may also be worth investigating for its potential tightening and lightening ability.

DISCLOSURES

No conflict of interest was reported.

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