Evaluation of the Safety and Efficacy of a Picosecond Alexandrite Laser With DLA for Acne Scars in Chinese Patients

Mengli Zhang, MD, Jing Fang, BS, Qiuju Wu, MS,* and Tong Lin, MD,*
Department of Cosmetic Laser Surgery, Hospital of Dermatology, Chinese Academy of Medical Sciences, Peking Union Medical College, Nanjing, 210042, P.R. China

Background and Objectives: Recently, picosecond laser treatment has been used as an effective treatment for acne scars. To evaluate the efficacy and safety of a picosecond alexandrite laser with a diffractive lens array in the treatment of acne scars in Chinese patients.
Study Design/Materials and Methods: Patients with facial acne scars were treated with a picosecond alexandrite laser in three sessions at 4- to 6-week intervals and followed up for 2 months. Primary outcomes were measured by physicians' blinded evaluation of the acne scar using the ECCA (échelle d'éva physicians'luation clinique des cicatrices d'acné) grading scale. The secondary outcomes included the investigator global assessment (IGA) on the improvement of post-inflammatory erythema (PIE), patients' assessment of improvement on a 4-point scale and of satisfaction on a 5-point scale. Pain scores and adverse effects were also evaluated.
Result: Twenty patients with Fitzpatrick skin types III and IV were enrolled in the study and completed all treatment and follow-up visits. The mean ECCA scores fell from 197.75 ± 35.26 to 142.00 ± 35.92 (a 28% improvement), and the change was significant ($P = 0.000$). The mean IGA score of PIE improvement was 3.03 ± 0.75 (0 = no improvement and 4 = 76–100% improvement). On the basis of the patients' self-assessment, the average improvement scores were 2.30 ± 0.98 (0 indicating 0–25% improvement and 3 indicating >75% improvement). In total, 50% and 30% of the patients were "satisfied" and "very satisfied," respectively, with the treatment. The mean pain score was 3.20 ± 0.50 (0 = no pain, 10 = maximum pain) with topical anesthesia. The adverse effects included transient and mild erythema, edema, and scabbing.
Conclusions: Treatment with a picosecond alexandrite laser with a diffractive lens array is effective and safe for acne scars in Chinese patients. Lasers Surg. Med. © 2019 Wiley Periodicals, Inc.

Key words: acne scars; alexandrite laser; picosecond laser; fractional laser; post-inflammatory erythema

INTRODUCTION

Acne is a common condition that affects up to 80% of the adolescent population. Permanent acne scars are a consequence of inflammatory damage around the hair follicle, resulting in cosmetic concerns and the possibility of severe psychological effects [1]. Different therapeutic modalities have been used over the years, such as surgical excision, dermabrasion, chemical peels, and diverse filler injection. Lasers, including fractional lasers, have been shown to be effective for the treatment of atrophic acne scars [2].

Recent studies have reported a lower occurrence of adverse effects with the use of nonablative fractional lasers for acne scars, which minimize epidermal and dermal injury. A new generation of technology, which includes a 755-nm picosecond alexandrite laser, has been approved by the Food and Drug Administration for the treatment of unwanted tattoos and pigmented lesions in the skin [3]. The picosecond laser delivers short pulse bursts of energy in the picosecond range (550–750 picoseconds) to the skin and is capable of generating both photothermal and photomechanical effects on the tissue while minimizing collateral thermal damage. Furthermore, an innovative optical attachment of this picosecond laser, a diffractive lens array (DLA), has been developed for delivering intensified energy in a fractionated manner while maintaining a low total fluence and achieving a high safety profile [4]. In recent years, a few studies have reported that the 755-nm picosecond alexandrite laser with a DLA could improve the appearance and texture of acne scars [3–6].

In this prospective clinical study, we evaluated the efficacy and safety of the 755-nm picosecond alexandrite

Conflicts of Interest: Conflict of Interest Disclosures: All authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest and none were reported. Contract grant sponsor: CAMS Innovation Fund for Medical Sciences; Contract grant numbers: CIFMS-2017-I2M-1-017 and 2018-I2M-AI-018; Contract grant sponsor: National Nature Science Foundation of China; Contract grant number: 81703142.
*Correspondence to: Qiuju Wu, Department of Cosmetic Laser Surgery, Hospital of Dermatology, 12 Jiang-wang-miao Street, Nanjing, Jiangsu 210042, P.R. China. E-mail: wqj0528@163.com; Tong Lin, Department of Cosmetic Laser Surgery, Hospital of Dermatology, 12 Jiang-wang-miao Street, Nanjing, Jiangsu 210042, P.R. China. Tel: +86-25-85478000; E-mail: ddlin@hotmail.com
Accepted 21 October 2019
Published online in Wiley Online Library (wileyonlinelibrary.com).
DOI 10.1002/lsm.23177

laser with DLA in the treatment of acne scars in a Chinese population.

MATERIALS AND METHODS

Patients

This study received approval from the ethics committee of the Hospital of Dermatology, Chinese Academy of Medical Science. After reading the experimental protocol, patients with acne scars on their cheeks gave their written informed consent for participation in the study. Exclusion criteria included a history of keloid scars, use of oral isotretinoin within the preceding 6 months, pregnancy and lactation, photosensitivity or current use of photosensitive drugs, known allergy to lidocaine, blood coagulopathy, any facial radiofrequency or laser treatment in the last 6 months, or therapy with immunosuppressive drugs.

Devices and Treatment Protocol

All patient's acne scars were treated with a 755-nm picosecond alexandrite laser with a DLA (PicoSure™; Cynosure Inc., Westford, MA), with a fluence of 0.71 J/cm^2, the spot size of 6-mm, pulse repetition of 5-Hz, and a pulse duration of 750 picoseconds for five passes. All patients received three sessions of laser treatment at 4- to 6-week intervals and followed up at 2 months after the final session. Topical anesthetic cream [7] with 2.5% lidocaine hydrochloric acid and 2.5% prilocaine (Beijing Ziguang Medication Manufacture Corporation Ltd., Beijing, China) was applied to the treatment area for 60 minutes before laser therapy. Ice packs were used to minimize heat and pain after the treatment. Direct sun exposure, heat, and friction were to be avoided.

Clinical Assessment

Clinical responses were evaluated using high-resolution digital photographs at baseline and at the 2-month follow-up period. The clinical response evaluation was performed by two independent physicians who did not participate in the study and did not know the treatment protocol. They scored the photographs of every patient. However, they did not know whether the photo was at baseline or at 2 months after the last treatment. They were asked to analyze the overall clinical efficacy of the treatment using the ECCA grading scale (échelle d'évaluation clinique des cicatrices d'acné) [8] and evaluate the improvement of acne-induced post-inflammatory erythema (PIE) by investigator global assessment (IGA) [9]. As shown in Table 1, the ECCA score is based on the weighted assessments of six types of acne scars: v-shaped atrophic, u-shaped atrophic, m-shaped atrophic, hypertrophic inflammatory and keloid scars, and superficial elastolysis. The global scores could vary from 0 to 540 depending on the severity of the scars in terms of their nature and number, as shown in Table 1. The IGA on PIE was comprised of five points associated with the degree of improvement (grade 0: no improvement, grade 1: 0–25% improvement, grade 2: 26–50% improvement, grade 3: 51–75% improvement, grade 4: 76–100% improvement).

Moreover, patients were required to assess the overall improvement of their acne scars on a 4-point scale[3] (0 indicating 0–25%; 1, 26–50%; 2, 51–75%; and 3, 76–100% improvement). They were also required to rate their satisfaction with the treatment on a 5-point scale [10] (-2 = very dissatisfied; -1 = Dissatisfied; 0 = No opinion; 1 = Satisfied; and 2 = Very satisfied). The patients were asked to rate their pain on a numerical scale ranging from 0 (no pain) to 10 (worst imaginable pain) during each treatment session. Other adverse effects, such as erythema, edema, oozing, bleeding, hyperpigmentation, and hypopigmentation, were documented.

Statistical Analysis

Statistical analyses were performed using SPSS version 18.0 (IBM-SPSS Inc., Armonk, NY). Descriptive data are presented as the mean values with standard deviation (SD). Data were evaluated using a paired t test, and statistical significance was defined as $P < 0.05$.

RESULTS

Patient Demographics

Twenty patients with Fitzpatrick skin types III and IV were enrolled in the study and completed all treatment and follow-up visits. There were 7 females and 13 males (mean age, 21.2 ± 2.2 years; age range, 19–28 years). Five patients (25%) were categorized as having Fitzpatrick skin type III, while 15 patients (75%) had type IV. The duration of the acne scars ranged between 0.5 years and 4 years, with a mean of 2.35 ± 1.03. The patient demographics are shown in Table 2.

Clinical Efficacy

According to the physicians' assessment, the acne scars showed significant clinical improvements with three treatments of 755-nm picosecond alexandrite laser at the 2-month follow-up compared with baseline. The ECCA scores fell from 197.75 ± 35.26 to 142.00 ± 35.92 (28% improvement), which was significant ($P = 0.000$). There were 95% (19/20) patients having PIE and the mean IGA score of PIE improvement was 3.03 ± 0.75 after three treatment of picosecond laser. Seventy percent of the patients showed more than 50% improvement of the PIE. As shown in Figures 1 and 2, the acne scars texture and post-inflammatory erythema improved significantly after three picosecond laser treatments.

On the basis of the patients' self-assessment, the average improvement score for the acne scars at the 2-month follow-up after the treatment was 2.30 ± 0.98 (score range of 0, indicating 0–25% improvement, to 3, indicating >75% improvement). In addition, patient satisfaction data showed that 50% and 30% of the patients were "satisfied" and "very satisfied" with the treatment results, respectively, with no patients "very dissatisfied" or "dissatisfied".

TABLE 1. ECCA (échelle d'éva physicians'luation clinique des cicatrices d'acné) Grading Scale

Description	Weighting factor (a)	Semi-quantitative score (b)	Grading (a × b)
V-shaped atrophic scars, diameter of less than 2 mm and punctiform	15	0 = no scar 1 = a few scars 2 = limited number of scars 3 = many scars	/_____/
U-shaped atrophic scars, diameter of 2–4 mm, with sheer edges	20	0 = no scar 1 = a few scars 2 = limited number of scars 3 = many scars	/_____/
M-shaped atrophic scars, diameter of more than 4 mm, superficial and with irregular surface	25	0 = no scar 1 = a few scars 2 = limited number of scars 3 = many scars	/_____/
Superficial elastolysis	30	0 = absent 1 = mild 2 = moderate 3 = intense	/_____/
Subgrade 1			/_____/
Hypertrophic inflammatory scars, scars of less than 2 years of age	40	0 = no scar 1 = a few scars 2 = limited number of scars 3 = many scars	/_____/
Keloid scars, hypertrophic scars, of more than 2 years of age	50	0 = no scar 1 = a few scars 2 = limited number of scars 3 = many scars	/_____/
Subgrade 2			/_____/
Global score (Subgrade 1 + 2)			/_____/

Safety Evaluation

All the patients received topical anesthesia before treatment. On a visual analog scale (0 = no pain, 10 = maximum pain), the pain scores were 3.20 ± 0.50 for the picosecond laser treatment. There were only transient and mild erythema and edema, which mostly disappeared within 2 days, and no oozing or bleeding on the face after the picosecond laser treatment. The scabbing was also small and mild, and it resolved after a few days. There was no hyperpigmentation or hypopigmentation. Overall, the picosecond laser was well-tolerated, and the patients experienced little to no recovery time.

TABLE 2. Subject Demographics

No. of patients who completed the study	20
Gender	
Male	13 (65%)
Female	7 (35%)
Age of patients (y)	
Mean ± SD (range)	21.2 ± 2.2 (19–28)
Fitzpatrick Skin Type	
III	5 (25%)
IV	15 (75%)
Duration of acne scars (y)	
Mean ± SD (range)	2.35 ± 1.03 (0.5–4)

DISCUSSION

Atrophic acne scars are dermal depressions commonly caused by the destruction of collagen after inflammatory acne and can be psychologically devastating, thus affecting the quality of life of patients [11]. There is a significant demand for cosmetic treatments for acne scars, and different therapeutic modalities have been used over the years, including ablative and nonablative laser treatment, each having varying degrees of success and adverse effects. Among them, ablative fractional laser, which uses arrays of microscopic thermal damage patterns to stimulate a wound healing response, has been widely used in the treatment of acne scars. Some studies have documented the efficacy of ablative CO_2 fractional lasers in the treatment of acne scars [12]. However, these treatments usually result in oozing, bleeding, long periods of erythema and edema, crusting, and post-inflammatory hyperpigmentation (PIH), which may cause discomfort and hinder a patient's ability to perform daily activities.

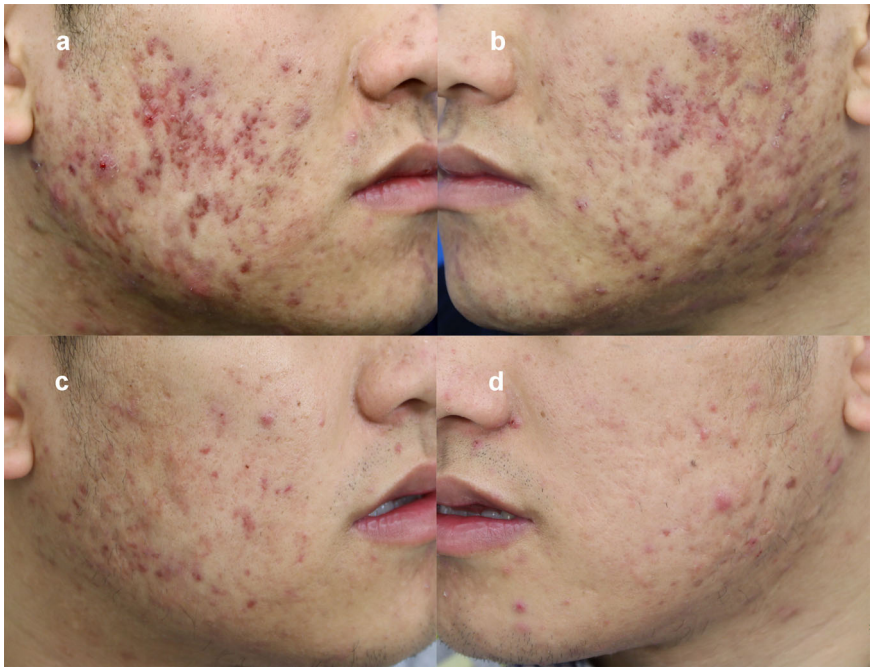

Fig. 1. The improvement in appearance and texture of an acne scar with a duration of 3 years before treatment (**a** and **b**) and 2 months after three treatments (**c** and **d**).

The picosecond laser is a ground-breaking innovation that can be used not only for the treatment of various pigmentary conditions [13,14] but also for improving skin texture and dyspigmentation, thereby obtaining a unique rejuvenation effect [15,16]. Rather than harnessing the principles of selective photothermolysis, picosecond lasers create zones of photomechanical (photoacoustic) trauma. As a result, the picosecond laser has a high specificity for its target but with less heat generation in the epidermal and dermal layers. This yields an opportunity to obtain

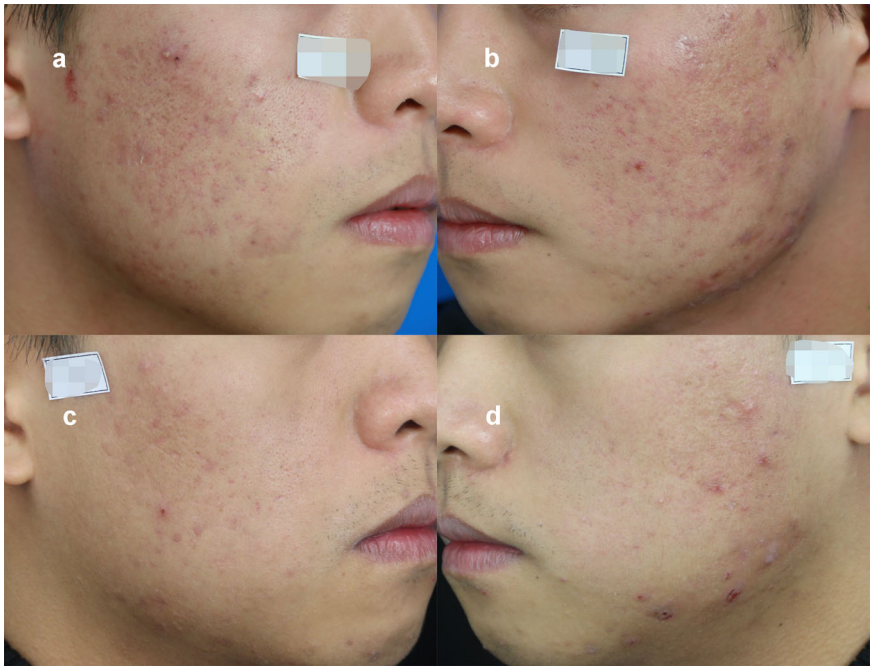

Fig. 2. The improvement in appearance and texture of an acne scar with a duration of 2 years before treatment (**a** and **b**) and 2 months after three treatments (**c** and **d**).

safer and more effective treatment of darker Fitzpatrick skin types without the significant risks of thermal diffusion to the surrounding tissues and possible PIH [4]. The DLA of the picosecond alexandrite laser changes the energy profile of the laser pulse and focuses 70% of the total pulse energy into fractionated micro-spots of high fluence surrounded by an even background distribution of the remaining 30% of the total pulse energy. Less than 10% of the tissue is exposed to this ultra-high energy, resulting in a laser-induced optical breakdown (LIOB) that is identified by pockets of intra-epidermal necrosis [4,17]. Thereafter, the energy absorbed by the LIOBs is efficiently converted into pressure waves that propagate into the dermis. This barotrauma may lead to the initiation of dermal remodeling from changes in cell signaling and the release of cytokines, which are beneficial to scar repair.

Recently, a few studies have shown that the use of a picosecond laser is safe and effective for the treatment of acne scars. Bernstein et al. [18] demonstrated that the picosecond-domain, 1,064 and 532 nm, Nd:YAG laser, when used with a holographic beam-splitter, was safe and effective for the treatment of facial acne scars. Brauer et al. [3] demonstrated favorable clinical outcomes in acne scar management using a picosecond alexandrite laser with DLA. Their three-dimensional analysis revealed improvement in scar volume that could be maintained for 3 months after treatment. Moreover, the histologic analysis also revealed elongation and increased the density of elastic fibers, with an increase in dermal collagen and mucin. Haimovic et al. [4] retrospectively reviewed the adverse events associated with treatment using a picosecond alexandrite laser with DLA in individuals with Fitzpatrick skin types IV to VI. The results showed that the transient side effects included hyperpigmentation, erythema, edema, crusting, and scabbing, which resolved within 2 weeks or often within a few days. In a retrospective analysis by Huang et al. [5], a picosecond alexandrite laser was also demonstrated to be effective and safe when treating atrophic acne scars in Asians. In addition to the scar texture, additional improvements in overall skin quality and pigmentation could also be obtained.

In conclusion, the results of our current study are consistent with these previous studies. The picosecond alexandrite laser with DLA was effective in improving scar texture and appearance, with mild adverse reactions and, usually, quick recovery times. Besides, the picosecond alexandrite laser could significantly improve acne-induced post-inflammatory erythema. Clinically, acne-induced PIE could be improved by intense pulsed light [19], fractional microneedling radiofrequency [9] and pulsed-dye laser [20]. According to our study, the picosecond alexandrite laser is also an effective and safe alternative in treating PIE. It should be noted that acne scars of different durations may have different responses to picosecond laser therapy. Our clinical experience shows that the effect of picosecond laser on a fresh acne scar is significantly better than it is on an old acne scar (data not shown). We speculate that the fresh scar with PIE is in a growing state and is susceptible to stimulation, which is easy to produce via various inflammatory factors and then stimulate collagen remodeling. In this study, the mean duration of the acne scars was 2.35 ± 1.03 years and the majority of patients had post-inflammatory erythema. Therefore, these acne scars are still relatively fresh, which may be an important factor for the efficacy of picosecond lasers in treating these acne scars. Additional clinical studies are necessary for further evaluation of the efficacy of picosecond lasers in treating different types of acne scars.

ACKNOWLEDGMENTS

This work was supported by the CAMS Innovation Fund for Medical Sciences (CIFMS-2017-I2M-1-017 and 2018-I2M-AI-018) and the National Nature Science Foundation of China (81703142). The trial registration number: ChiCTR1800019028.

ORCID

Qiuju Wu http://orcid.org/0000-0001-7720-4982

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