Noninvasive Atrophic Acne Scar Treatment in Asians With a 755-nm Picosecond Laser Using A Diffractive Optic Lens—A Retrospective Photographic Review

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BACKGROUND The diffractive lens of the picosecond laser is relatively new, and there are few reports on its efficacy in treating atrophic acne scars, especially in Asian populations.

OBJECTIVE Evaluating the efficacy of diffractive lens 755-nm picosecond laser for atrophic acne scar treatment in Asians.

PATIENTS AND METHODS Forty-two patients who were treated for facial atrophic acne scars at a private dermatological clinic were enrolled in this retrospective analysis. Mean session count was 4.28. Before and after photographs were assessed by 2 blinded dermatologists, who rated the amount of overall skin quality improvement on a 5-point scale.

RESULTS All patients experienced improvements in scar texture and overall skin quality after 2 to 6 sessions, with scores of +1.4, 1.45, 1.7, 1.33, 2.3, and 1.66 points after 2, 3, 4, 5, 6, and >6 treatments, respectively. There were no obvious adverse effects after treatment. The postinflammatory hyperpigmentation (PIH) risk was 4.7% (2 of 42, both spontaneously resolved).

CONCLUSION The 755-nm diffractive lens picosecond laser showed good efficacy and low PIH rates when treating atrophic acne scars in darker skin–type patients. In addition to treatment results, additional improvements in overall skin quality and pigmentation make the picosecond laser an effective and desirable treatment option for Asians.

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Acne is one of the leading dermatologic conditions in Asian populations. The inflammatory process of acne induces the loss of collagen and elastic tissue, eventually forming atrophic acne scars. Acne scars can be a source of psychological stress and can significantly affect a patient's self-confidence[1]—treatment requests are often for scar discoloration and disfiguration instead for the underlying acne.

Several treatment options are available for atrophic acne scars, such as chemical peeling, mechanical dermabrasion, subcision, punch graft, filler augmentation, and laser resurfacing.[2]

Laser resurfacing can be further divided into traditional devices and fractional devices. Traditional ablative laser resurfacing is less commonly used because of its prolonged wound healing process, increased risk of wound infection, and the possibility of postinflammatory side effects.

Fractional photothermolysis was approved by the US FDA for treating atrophic acne scars in 2006. Fractional laser resurfacing is characterized by its microscopic treatment zone injury and good clinical efficacy; in Asian patients, it generally causes few adverse events and has a shorter recovery time when compared with traditional dermabrasion methods.[3] However, postinflammatory hyperpigmentation (PIH) remains a

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major complication that may persist for months in dark-skinned patients, especially after treatment with ablative fractional devices.[4] That being said, the higher treatment response of fractional laser devices makes it an attractive option over nonablative lasers such as the long-pulsed 1,450-nm diode, and the 1,320- or 1,064-nm Nd:YAG.[5]

While the picosecond laser device was originally intended for the removal of unwanted tattoos,[6–9] a specific diffractive lens array modifies the picosecond alexandrite laser beam to produce high-intensity fluence. Increased collagen production and similar effects were noted in patients treated by the lens array and verified through histologic evidence.[10,11] In the last 2 years, indications for the picosecond laser have expanded beyond tattoo removal, and good clinical results have been achieved in skin rejuvenation, décolletage improvement, and atrophic acne scar treatment.[11–13]

In this report, we aim to analyze the efficacy and safety of the 755-nm alexandrite picosecond laser (PicoSure, Cynosure) for atrophic scar treatment in Asians. We hope our experiences can provide useful information for physicians seeking to treat atrophic acne scars in dark skin types with this new laser technology.

Materials and Methods

We treated patients with facial atrophic acne scars using a specific diffractive lens array of the picosecond 755-nm alexandrite laser in a private dermatologic clinic within a 24-month period (October 2014–October 2016). We then performed a retrospective analysis on those patients. Patients who had previously received laser dermabrasion, any type of fractional resurfacing, subcision, or filler augmentation procedures up to 6 months before treatment was excluded. All patients exhibited mixed atrophic acne scars, including rolling, box-car, and ice-pick types. Topical anesthetic cream (lidocaine 2.5% and prilocaine 2.5%) was applied on the area of treatment through cling-film occlusion for 30 minutes before each session. The same selective spot size, fluence, frequency, and pulse duration were used for all patients (6 mm, 0.71 J/cm^2, 10 Hz, and 750 ps, respectively). The number of laser passes differed between individuals, although at least 3 to 4 passes were performed, and the mean pulse count for whole face treatment was around 2,500 per session. Focus lens pulses were concentrated in areas with the most prominent acne scars, and these areas usually received about 4 to 6 passes. Patients also received flat-top pulses in areas without scarring in an attempt to even out post-treatment erythema, although flat-top counts varied by session and was not included in the data. Each session took about 10 to 15 minutes on average. Short-term prophylactic antibiotic was prescribed for the prevention of acneiform eruption: oral doxycycline (100 mg b.i.d. for 3–7 days, starting immediately after treatment) and topical clindamycin gel. All patients, especially those prone to oily skins, were prescribed the regimen unless they refused. Additional prophylactic herpes simplex virus treatment was only prescribed for patients who had a history of oral or perioral herpetic infections. Low to mid potency topical steroids (potency 7 hydrocortisone cream and potency 5 betamethasone valerate cream) were prescribed to all patients, but patients were advised to only use in the case of itching or prolonged erythematous symptoms in the first week after treatment. Other topical whitening creams were not routinely given in our cases series.

Two-dimensional photographs (Nikon D90) were taken between 3 weeks to 3 months after each session of treatment. Because the diffractive lens array consists of closely packed individual hexagonal lenses that condense high-fluence laser energy into a total area of less than 10% of the targeted treatment zone, several sessions of treatment were needed to accumulate enough collagen production. We assessed patient clinical response according to the number of treatment sessions—from 2 to more than 6. Two independent masked dermatologist evaluators assessed and scored the improvements in overall skin texture and appearance using before and after photography on a 5-point scale (0: no improvement; +1: <25% improvement; +2: 26%–50%; +3: 51%–75%; and +4: 76%–100%). Adverse reactions were also documented. Kendall coefficient of concordance was used to assess the degree of agreement between scores evaluated by the 2 physicians, although physician raters were not blinded to whether photographs were before or after.

Results

Fifty-three patients who had received the diffractive lens picosecond laser treatment from the clinic were reviewed. Forty-two patients (28 men, 14 women, ages 25–48 years, mean age 33 years) were ultimately enrolled in the study, after the exclusion of 2 cases who had received a combination treatment with filler injection, and 9 cases who had undergone fractional laser treatment within 6 months of picosecond laser treatment. The number of treatments ranged from 2 to 12 times (mean 4.28 times), with a treatment interval of one session per 2 to 6 weeks. Most patients followed our recommendation of roughly 1 session per month. Photographic follow-up was attempted for all patients after final treatment, and the mean length of follow-up was 7.3 weeks, with a range of 2 to 26 weeks. Six patients had a follow-up time of less than 4 weeks.

All patients exhibited variable improvement in their acne scars after treatment. Table 1 lists all participants'

TABLE 1. Age, Sex, Number of Sessions, and Physician Assessment Scores by Case

Case	*1**	*2*	*3*	*4*	*5†*	*6*	*7*	*8*	*9*	*10*
Age/sex	46/M	27/M	40/M	30/M	30/M	25/M	32/M	34/F	44/F	25/M
Sessions	4	6	2	6	6	4	6	4	4	4
Rater 1	1	2	1	2	2	3	3	1	2	3
Rater 2	1	1	1	3	2	3	2	2	2	2
Case	*11*	*12*	*13*	*14*	*15‡*	*16*	*17*	*18*	*19*	*20*
Age/sex	35/M	34/M	43/F	32/M	26/M	31/F	31/F	25/M	29/F	42/F
Sessions	8	2	3	4	4	8	12	2	3	3
Rater 1	2	1	1	1	2	2	1	1	1	1
Rater 2	2	2	2	2	2	2	1	1	1	1
Case	*21*	*22*	*23*	*24*	*25*	*26*	*27*	*28*	*29*	*30*
Age/sex	31/F	24/F	46/F	30/M	27/M	24/M	23/M	30/M	25/M	38/M
Sessions	4	5	2	6	4	3	3	3	2	6
Rater 1	2	1	1	1	1	2	1	1	2	2
Rater 2	2	1	2	2	1	2	1	1	2	1
Case	*31*	*32*	*33*	*34*	*35*	*36*	*37*	*38*	*39*	*40*
Age/sex	31/M	38/M	38/M	40/F	31/F	24/M	22/M	32/M	35/M	48/M
Sessions	5	6	6	3	4	3	3	3	5	5
Rater 1	1	1	2	2	1	2	2	1	2	1
Rater 2	1	1	1	2	1	2	2	1	2	1

Case	*41*	*42*	*Mean*
Age/sex	32/F	27/F	33
Sessions	5	5	4.28
Rater 1	1	2	
Rater 2	1	2	

*Case exhibited improvement in pigmented lesion in addition to acne scars.

†Case experienced postinflammatory hyperpigmentation (PIH) after Session 2 and Session 5 of treatment, which both spontaneously subsided.

‡Case exhibited improvement of red pigmentation in addition to acne scars. Case experienced PIH after Session 1 of treatment, which spontaneously subsided.

age, sex, and improvement scores assessed by 2 blinded dermatologists. Kendall coefficient of concordance was calculated to be 0.795, indicating "highly consistent" scores between the 2 raters. At the time of final assessment, the mean scores of improvement were +1.4, 1.45, 1.7, 1.33, 2.3, and 1.66 in cases who underwent 2, 3, 4, 5, 6, and >6 treatments, respectively (Table 2). Among different scar types, the rolling and superficial box-car types uniformly showed the most improvement (Figures 1 and 2). Case 1 additionally experienced a lightening of pigmented lesions after 2 sessions of treatment (Figures 3 and 4). Case 15 experienced similar, significant improvements in red scars and discolored scars after 3 sessions of treatment (Figures 5 and 6).

TABLE 2. Number of Patients and Improvement Scores Organized by Number of Treatment Sessions

No. of Sessions	*No. of Patients*	*Average Improvement Score*
2	5	1.4
3	10	1.45
4	10	1.7
5	6	1.33
6	8	2.3
>6	3	1.66

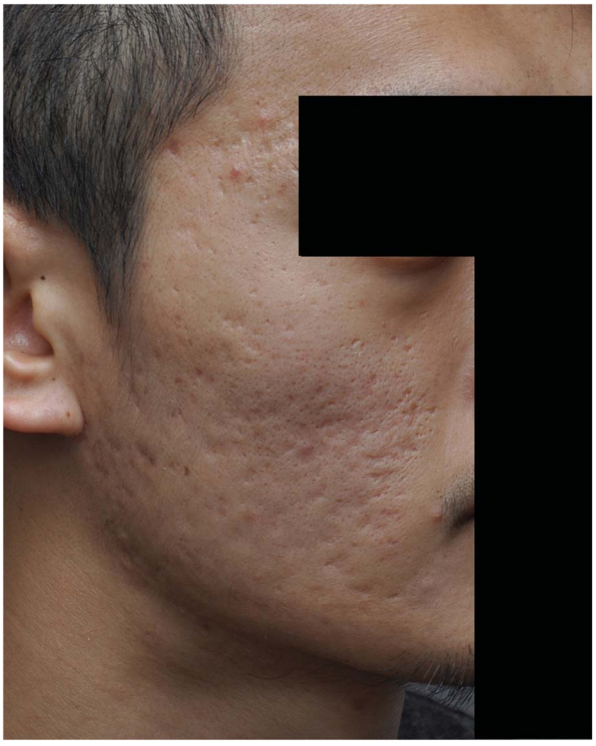

Figure 1. A patient before 2 sessions of full-face treatment.

The treatment was well-tolerated by all patients. The most commonly reported side effects include transient erythema, local heat over treated area, and pain during treatment. Erythema usually subsided in less than 24 hours, although lasted up to 3 days in rare cases. Transient PIH was noted in 2 cases by the midcourse of treatment. The first case (Case 5) noticed a grayish facial hue about a week after his second session of diffractive lens treatment (2,500 pulses, whole face), which spontaneously subsided without any medical intervention 3 weeks later. He experienced another episode of PIH after his fifth session of treatment. The second case (Case 15) developed PIH after his first treatment session (2,507 pulses, whole face) as an increase in pigmentation over the whole face, which had likewise

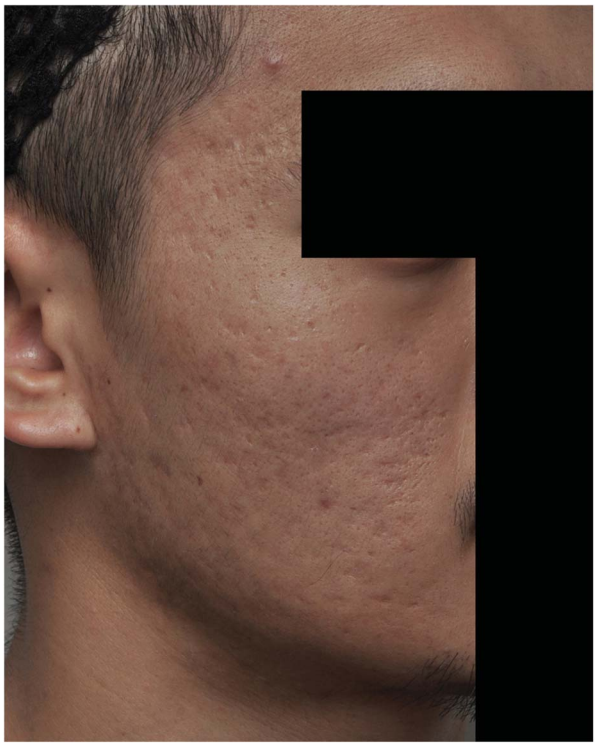

Figure 2. The same patient after 2 sessions of full-face treatment, demonstrating the typical effect of treatment on atrophic acne scars—superficial rolling type scars in particular. This patient is also an example of a typical treatment result rated as "+2 score" (25%–50% improvement) on our scale by both physician raters.

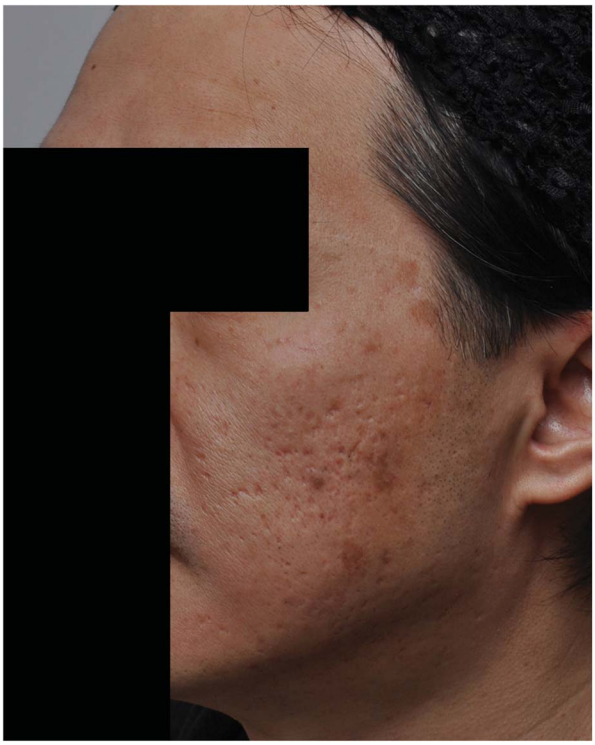

Figure 3. Case 1 before treatment, with visible pigmented lesions and acne scars over the cheeks and temples.

Figure 4. Case 1 after 2 sessions of full-face treatment, with lightening of pigmented lesions in addition to improvement of acne scars. This patient is also an example of a typical treatment result rated as "+1 score" (<25% improvement) on our scale by both physician raters.

spontaneously resolved by the time of his 3-month postprocedure photograph.

Discussion

Dr. Geronemus and colleagues first suggested the novel picosecond diffractive lens as a favorable treatment for atrophic acne scars in 2015, on patients with skin Types I to IV.[11] To the best of our knowledge, this is the first report analyzing atrophic acne scar treatment efficacy with the new diffractive lens for the alexandrite picosecond laser (PicoSure) in Asians. Our study was conducted using settings identical to the study by Geronemus and colleagues, and our data support their recommendation. Forty-two patients (skin Types III–V) exhibited an average of >25% improvement in overall scar severity after an average of 4.28 sessions, and of the 8 patients who underwent 6 treatment sessions, all were rated as having >50% improvement in their atrophic acne scars. These results indicate both near-universal overall improvement and substantial per-session improvement in darker skinned Asian patients, which may be due to increased laser energy absorption by melanin chromophores in patients with darker skin types.

According to a histological analysis by Tangetti,[10] darker skinned patients with higher melanin indices definitively demonstrated a specific kind of intraepidermal injury (laser-induced optic breakdown (LIOB) formation). Current theory links LIOB with the production of dermal collagen, elastic tissue, and mucin, which may also help explain the differences in treatment efficacy between various skin types.

Although fractional laser resurfacing provides promising results in atrophic acne scar treatment,[1,3] prolonged postprocedure erythema and hyperpigmentation due to epidermal damage remain a source of dissatisfaction in Asian patients. The PIH risk in Asians was reported by Chan and colleagues as 18.2% with nonablative fractional lasers and 55% with fractional ablative CO_2 lasers.[14,15] By

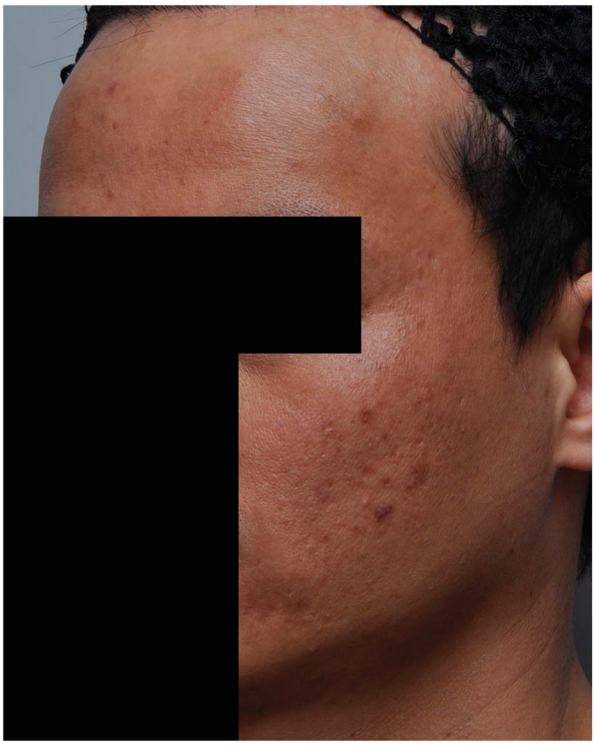

Figure 5. Case 15 before treatment, showing atrophic and red acne scars over the cheek area.

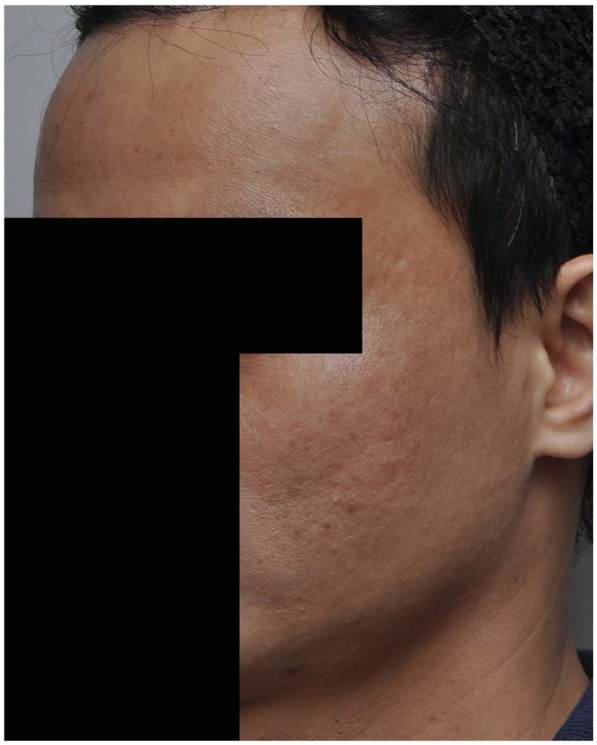

Figure 6. Case 15 after 3 sessions of full-face treatment, with improvement of scar color in addition to scar quality.

contrast, picosecond lasers deliver energy with damage confined to the epidermis, so excessive radiation does not reach the dermoepidermal junction, which minimizes the risk of undesirable skin discoloration in patients with pigmented skin.[16] For example, only 2 cases of 42 in this series (4.7%) developed transient PIH during the treatment period. On a by-session basis, taking each session of each patient into account, the incidence rate of PIH was 3 sessions of a total of 180 (1.7%). Interestingly, the 2 cases who did develop PIH presented with a grayish hue over the whole face, rather than a localized hyperpigmentation over the area of atrophic scarring. The cause of this unusual pattern of PIH is unclear but may be due to melanin particle disruptions overwhelming the individual's melanin clearance ability. The mechanism for the improvement of discolored and red scars (Cases 1 and 15) is likewise unknown—cytokine cascades associated with collagen remodeling may play a role.

No consensus scale system exists in literature for the assessment of atrophic acne scar improvement. Because most patients exhibited mixed atrophic scarring, different individuals often presented with a variety of scar types in different proportions and different severities, each of which might then respond differently to treatment. As a result, it is challenging to objectively quantify the degree of improvement or response, and our study is limited by its reliance on the expertise of clinically experienced dermatologists for numerical assessment scores. For pictorial reference, Figures 3 and 4 show the typical amount of scar change in patients with an improvement score of +1; Figures 1 and 2 show the typical amount of scar change in patients with an improvement score of +2; and Figures 7 and 8 show the typical amount of scar change in patients with an improvement score of +3. Our Kendall coefficient result indicates "highly consistent" scores between our raters, and by averaging the 2 physicians' given scores, a strong positive correlation between the number of treatment sessions and the amount of improvement can still be seen. However, as previously mentioned, physicians were not blinded to whether photographs were before or after, and subsequent confirmation bias may have

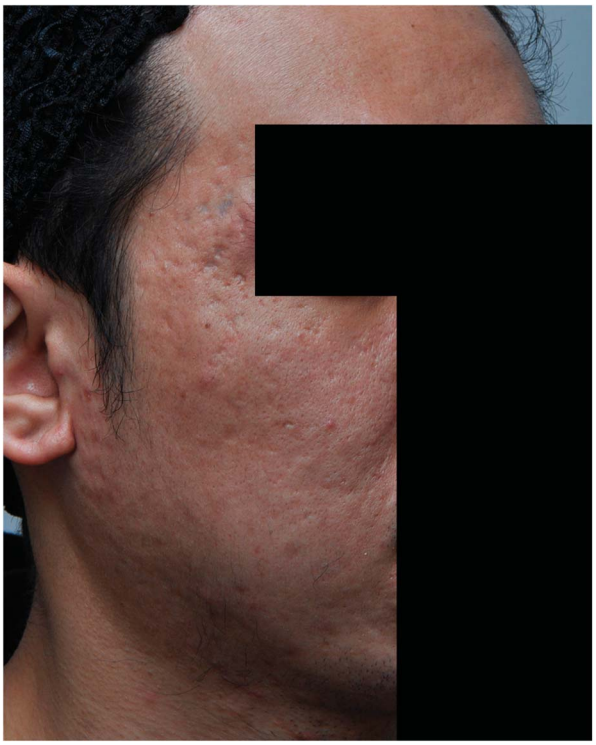

Figure 7. An example of temple atrophic acne scar before full face diffractive lens treatment.

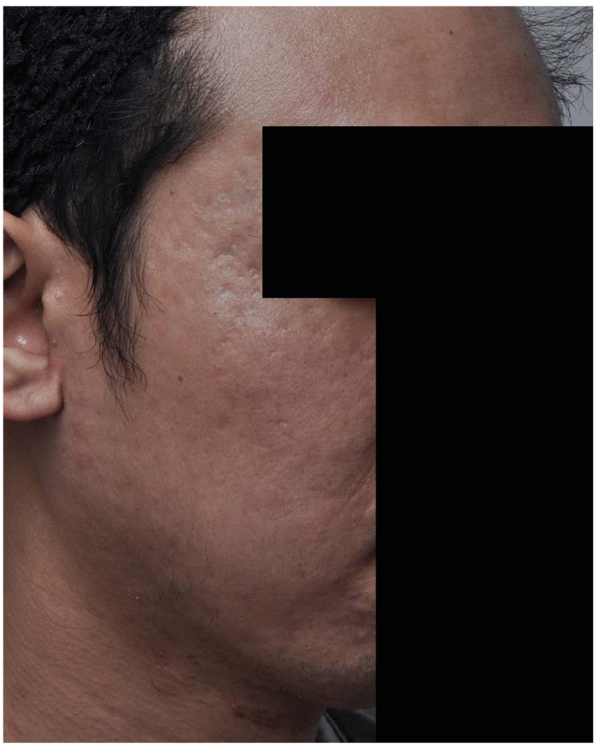

Figure 8. The same case showed a typical treatment result rated as "+3 score" (50%−75% improvement) on our scale by both physician raters.

resulted in an overestimation of improvement in cases with lower scores.

Theoretically, the high energy fluence of specific diffractive lenses deliver energy to less than 10% of the treated area in a single pass, creating a fractional-like patterns of microscopic thermal lesion zones, and leaving gaps of intact epidermis. This facilitates healing and collagen production while minimizing adverse side effects. The efficacy can be enhanced by increasing the number of lesions (i.e., more passes), or by increased repetition of the lesion-healing process (i.e., more sessions). Although 2,500 pulses for the whole face (the average in our study) may seem low to physicians who predominantly treat white patients, focus lens pulses were mostly concentrated in areas with the most prominent acne scars (usually the temples, cheeks, and nose), with these areas receiving 4 to 6 passes. Haimovic and colleagues[16] administered 3,000 to 7,000 pulses in 2 to 4 passes for the whole face on 56 patients with darker skin types, 10 of whom were lost to follow-up after the first treatment. Perhaps due to the increased pulse count used, they reported side effect rates somewhat higher than our own: 6 cases developed PIH, 7 developed erythema, 1 developed scabs, and 3 developed edema. Because a satisfactory level of efficacy was usually achieved with 2,500 pulses manually concentrated in areas of scarring, we deemed this pulse count adequate for Asian patients.

In general, the results were consistent with our expectations, showing a positive correlation between session number and improvement. Average score improvement was +1.4 for patients after 2 sessions, +1.7 after 4 sessions, and +2.3 after 6 sessions. However, a notable exception lies in patients who underwent 5 sessions, which may have been due to 2 outlier cases: one case (Case 41) in that group had a shorter follow-up period (1 month after last treatment), and another (Case 22) exhibited mainly deep box-car type acne scars.

Both the total number of patients and the number of subjects in each group limits our analysis. As mentioned, raters were not blinded to whether photographs were before or after, and confirmation

bias may exist. Also, because this study was retrospective, information about subjects could only be based on previous medical records and photographs. More or larger case series may provide stronger evidence for the optimal treatment regimen and protocol, and further study is required to determine long-term clinical efficacy.

Conclusion

From its original intended use in tattoo and pigment removal, to the treatment of acne scars and pigmented lesions as demonstrated in this report, indications for the picosecond laser have continued to expand. Treating atrophic acne scars in Asians with the diffractive lens array of the alexandrite picosecond laser produces good clinical results as confirmed by independent observation, with the added benefit of almost zero downtime. Furthermore, the reduced risk of postprocedure PIH in dark-skinned patients makes the picosecond laser a treatment of choice for atrophic acne scars in Asians. Together with other aforementioned indications, the picosecond laser covers most cosmetic complaints seen in Asian patients. As such, a combination treatment using both diffractive and regular lenses of the picosecond lasers may be the ideal starting treatment for common dermatological problems in darker skinned peoples.

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