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ORIGINAL ARTICLE

Efficacy and Safety of Treatment with Fractional 1,064-nm Picosecond Laser with Diffractive Optic Element for Wrinkles and Acne Scars: A Clinical Study

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Background: Fractional picosecond lasers is effective for the treatment of wrinkles or acne scars. **Objective:** To investigate the safety and efficacy of treatment with a fractional 1,064-nm picosecond laser with a diffractive optic element for facial wrinkles and acne scars. **Methods:** This prospective open-labeled trial comprised 22 subjects with facial wrinkles or acne scars. Subjects received three laser treatments with a fractional 1,064-nm picosecond laser at 3-week intervals. The efficacy and safety were evaluated at every visit and 2 months after the final treatment (14 weeks from the first treatment session). Global photographic assessments were performed by three blinded dermatologists and the subjects. Skin profilometry was performed using three-dimensional digital photographs; viscoelasticity was measured. **Results:** The overall mean global improvement scores assessed by the dermatologists at weeks 3, 6, and 14, were 1.8 ± 1.46, 2.5 ± 1.88, and 3.5 ± 1.84, respectively, and those assessed by the subjects were 2.7 ± 2.08, 4.1 ± 2.24, and 5.0 ± 2.52, respectively. Skin profilometry showed significant improvements in the skin wrinkles, texture, depressions, and pores. The gross elasticity and skin firmness significantly improved by 10.96% and 9.04%, respectively. The major adverse reactions were erythema, pruritus, and petechiae, which disappeared within 2～3 days. **Conclusion:** The fractional 1,064-nm picosecond laser is an effective and safe therapeutic modality for skin rejuvenation. **(Ann Dermatol 33(3) 254～262, 2021)**

-Keywords-
Diffractive optic element, Nd-YAG lasers, Picosecond, Skin rejuvenation

INTRODUCTION

Skin rejuvenation is the restoration of the structural changes and reversing the effects of the skin aging process, usually by using cosmetic procedures. It has advanced as a non-invasive or minimally invasive surgical approach over time. Optical and laser therapy, micro-needling, and platelet-rich plasma (PRP) are widely used for skin rejuvenation. Among these therapeutic options, non-ablative fractional laser treatment has the advantages of a short downtime, fewer adverse effects, and minimal or no epidermal injury, leading to improvements in the skin texture, wrinkling, and pigmentation[1].

In the recent past, the picosecond pulsed laser system was introduced to shorten the pulse duration from the nanosecond (10^{-9}) to picosecond (10^{-12}) level. As a picosecond is much shorter than a nanosecond, this system has several advantages. Although the nanosecond and picosecond laser devices can produce a high target temperature suitable for removing the chromophore, the faster rate of pulse delivery of picosecond lasers allows for the generation of a higher target pressure, with limited thermal damage to the surrounding tissue. As picosecond lasers cause more photomechanical damage than nanosecond

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lasers do, they have a greater advantage of degrading pigment or ink particles. Thus, the picosecond lasers were initially used for the removal of tattoos and pigmentation in the clinical setting[2-7].

Beyond the usual device for tattoo removal, the picosecond lasers with fractional modes (diffractive optical element [DOE] or microlens array [MLA]) were also introduced. Densely arranged micro-lenses split the picosecond pulses into columns of high fluence, which irradiate only 10% of the target spot, and the background is receives low-intensity laser pulses. The sites irradiated with a high-fluence laser consume approximately 20-times more energy than the background areas irradiated by a low-energy laser pulse. The high fluence of fractionated laser pulses induces collagen and elastin synthesis via photothermal and photomechanical effects without surface ablation[8]. Recent clinical studies with fractional picosecond lasers reported that clinical improvement can be achieved only after 3 to 4 laser treatment sessions for skin rejuvenation (particularly for wrinkles or acne scars). The patients reported mild erythema, swelling, and pain as common adverse effects, which spontaneously subsided within a few days[9-13]. The clinical importance of fractional picosecond laser is expected to gradually increase in the field of aging or scar treatment. Thus, we aimed to elucidate the effects of fractional 1,064-nm picosecond laser treatment on skin rejuvenation, particularly on wrinkles and acne scars, using multiple objective assessment methods.

MATERIALS AND METHODS

The study protocol was approved by the Institutional Review Board (IRB) of Dankook University Hospital (DKUH-2018-02-012). Informed consent was obtained from all the participants. In addition, only subjects who agreed that research data, such as clinical pictures, could be used for publication at a non-personally identifiable level were included in the study.

Subjects

This single-center prospective study was performed between October 2018 and January 2019. Female and male subjects, aged 19 to 80 years, with facial wrinkles or acne scars were enrolled. The exclusion criteria were, as follows: pregnancy or lactation, keloid scar formation history, presence of active infection, corticosteroid or isotretinoin treatment, any esthetic treatment for the face within 2 months before the study, concurrent systemic diseases (e.g., diabetes mellitus, hypertension, cardiovascular disease, cancer, and acute systemic infection), and suspected mental illness.

Treatment protocol

The 1064-nm picosecond Nd:YAG laser (PicoLo®; Laseroptek, Seongnam, Korea) with a DOE fractional handpiece was used for all treatment sessions. Three treatment sessions were provided at 3-week intervals (by Dr. SP Hong). Before treatment, all subjects cleansed their face and applied a topical anesthetic (EMLA®; AstraZeneca, Sodertalje, Sweden) to the whole face 1 hour before laser treatment. The anesthetic was removed softly. In one treatment session, 3～5 passes were performed in which a minimum of 2,200～2,600 shots were delivered to the full face (energy, 0.22～0.30 J/cm^2; spot size, 7 mm; repetition rate, 4 Hz; and pulse duration, 450 ps). The subjects wore protective eyewear; appropriate goggles were worn by the treating physicians. The clinical endpoint was mild to moderate erythema. After the procedure, an ice pack was applied for 20 minutes.

Evaluation of treatment efficacy

The treatment efficacy was assessed at every visit. The final evaluation was conducted at 8 weeks after the last treatment session (14 weeks after the first session). A global photographic assessment using standardized two-dimensional (2D) digital photographs was performed by three individual dermatologists who were blinded to the study information. The three dermatologists individually evaluated the degree of improvement by comparing the photographs obtained before and after treatment. The dermatologists were first asked to identify which photographs was the baseline image. The dermatologists then evaluated the clinical improvement using a 10-point global aesthetic improvement scale (GAIS; 1=10% improvement, 2=20% improvement to 10=100% improvement). If the dermatologists incorrectly identified the baseline image, the evaluated global improvement score was negative (e.g. a score of 5 was rated as −5, signifying that the subject's condition worsened by 50% after treatment). Skin surface profilometric analysis of the skin wrinkles, texture, depressions, and pores was performed. Three-dimensional (3D) digital photographs were taken and analyzed objectively using a built-in imaging analysis system (ANTERA 3D®; Miravex Limited, Dublin, Ireland). The skin viscoelasticity was measured on the both cheeks by using Cutometer® (Courage+Khazaka Electronic GmbH, Koln, Germany). The skin surface profilometric analysis and the measurement of skin viscoelasticity were performed at every visit. All these measurements were recorded by the same investigator in the same room (room temperature, 22°C) at the exact same skin site according to the baseline photograph to ensure standardization of measurement. The subjects

assessed their clinical improvement using a 10-point GAIS by themselves.

Safety evaluation

The therapeutic method used in this clinical trial was expected to cause adverse reactions similar to those caused by general cosmetic laser treatments, such as pruritus, pain, blisters, and hyperpigmentation. The adverse events identified through history-taking and physical examinations were evaluated at regular or additional visits. The adverse events were classified according to three severity grades, namely, mild, moderate, and severe adverse events. Mild adverse events involved manifestation of signs or symptoms that did not interfere with the subject's usual activity. Moderate adverse events involved manifestation of signs or symptoms that interfered with the subject's usual activity, and severe adverse events involved incapacity with an inability to work or perform usual activities.

Statistical analyses

To evaluate the significant differences after laser treatment, the data for the global photographic assessment, global assessment by the subjects, profilometric measurements (skin wrinkles, texture, depression, and pores), and skin viscoelasticity (gross elasticity, net elasticity, and skin firmness) were analyzed. The Wilcoxon signed-rank test was used to compare the differences between the values recorded before and after treatment. The interclass correlation coefficient was calculated to identify the inter-rater reliability of the global photographic assessment. All statistical analyses were performed using IBM SPSS ver. 26.0 (IBM Corp., Armonk, NY, USA); a p-value of <0.05 was considered statistically significant.

RESULTS

Characteristics of the subjects

The characteristics of the subjects are described in Table 1. A total of 22 adult subjects, comprising 15 females and 7 males, were enrolled. The mean subject age was 39.6 years. All subjects received three sessions of laser treatment; none of the subjects dropped out of the study. Twelve of 22 subjects were treated for improving the facial wrinkles, and all the subjects were females. The mean Fitzpatrick wrinkle and elastosis scale (FWS) score[14] was 2.10 ± 0.63 for perioral wrinkles, 1.83 ± 0.43 for periocular wrinkles and 1.95 ± 0.85 for forehead wrinkles (Supplementary Table 1). The other 10 subjects (7 males and 3 females) were treated for improving the acne scars. The mean grade of the global acne scarring grading system[15] was 2.80 ± 0.78. The mean FWS score and mean global acne scarring grade showed significant improvement at week 14.

Table 1. Characteristics of the subjects

Variable	Wrinkle	Acne scar	Total
No. of subjects	12	10	22
Female	12 (100)	3 (30.0)	15 (68.2)
Age (yr)	47.4 ± 9.9	30.4 ± 10.4	39.6 ± 13.2
Height (cm)	159.4 ± 4.8	172.9 ± 8.4	165.5 ± 9.4
Body weight (kg)	57.2 ± 5.1	71.2 ± 16.5	63.6 ± 13.6
Body mass index (kg/m^2)	22.6 ± 2.4	23.5 ± 3.7	23.0 ± 3.1

Values are presented as number (%) or mean±standard deviation.

Clinical outcomes

1) Global photographic assessment

The inter-rater reliability of the global photographic assessment system used in this study was verified. Three individual dermatologists were in almost perfect agreement with the global photographic assessment results, as denoted by the intraclass correlation coefficients (Fleiss kappa coefficient at week 3: 0.877, 95% confidence interval [CI]: 0.749～0.945; at week 6: 0.908, 95% CI: 0.813～0.959; at week 14: 0.871, 95% CI: 0.738～0.942; Supplementary Table 2). Statistically significant improvements were noted after all treatment sessions compared to the baseline, and the improvement rate also increased with repeated treatment. For all the subjects, the mean improvement scores on the 10-point GAIS were 1.8 ± 1.46, 2.5 ± 1.88, and 3.5 ± 1.84 at weeks 3, 6, and 14, respectively (Fig. 1A). The values showed significant differences compared to the baseline values when the subjects with wrinkles or acne scars were analyzed separately. The subjects with wrinkles showed mean improvement scores of 1.3 ± 1.32, 2.2 ± 1.08, and 3.2 ± 1.57 at weeks 3, 6, and 14, respectively. The subjects with acne scars showed mean improvement scores of 2.3 ± 1.89, 3.0 ± 2.5, and 3.8 ± 2.16 at weeks 3, 6, and 14, respectively (Fig. 1B). Although greater improvement was observed at each visit in the acne scar group, the mean improvement scores were not significantly different between the two subject groups.

2) Global assessment scores evaluated by subjects

The overall mean improvement in the global assessment scores by the subjects were 2.7 ± 2.08, 4.1 ± 2.24, and 5.0 ± 2.52 at weeks 3, 6, week 14, respectively (Fig. 1C); the scores were slightly higher than those assigned by the dermatologists. The subjects with wrinkles showed mean improvement scores of 3.0 ± 2.47, 4.3 ± 2.68, and 5.1 ± 3.03 at weeks 3, 6, week 14, respectively. The subjects with acne scars showed mean improvement scores of 2.4 ± 1.5,

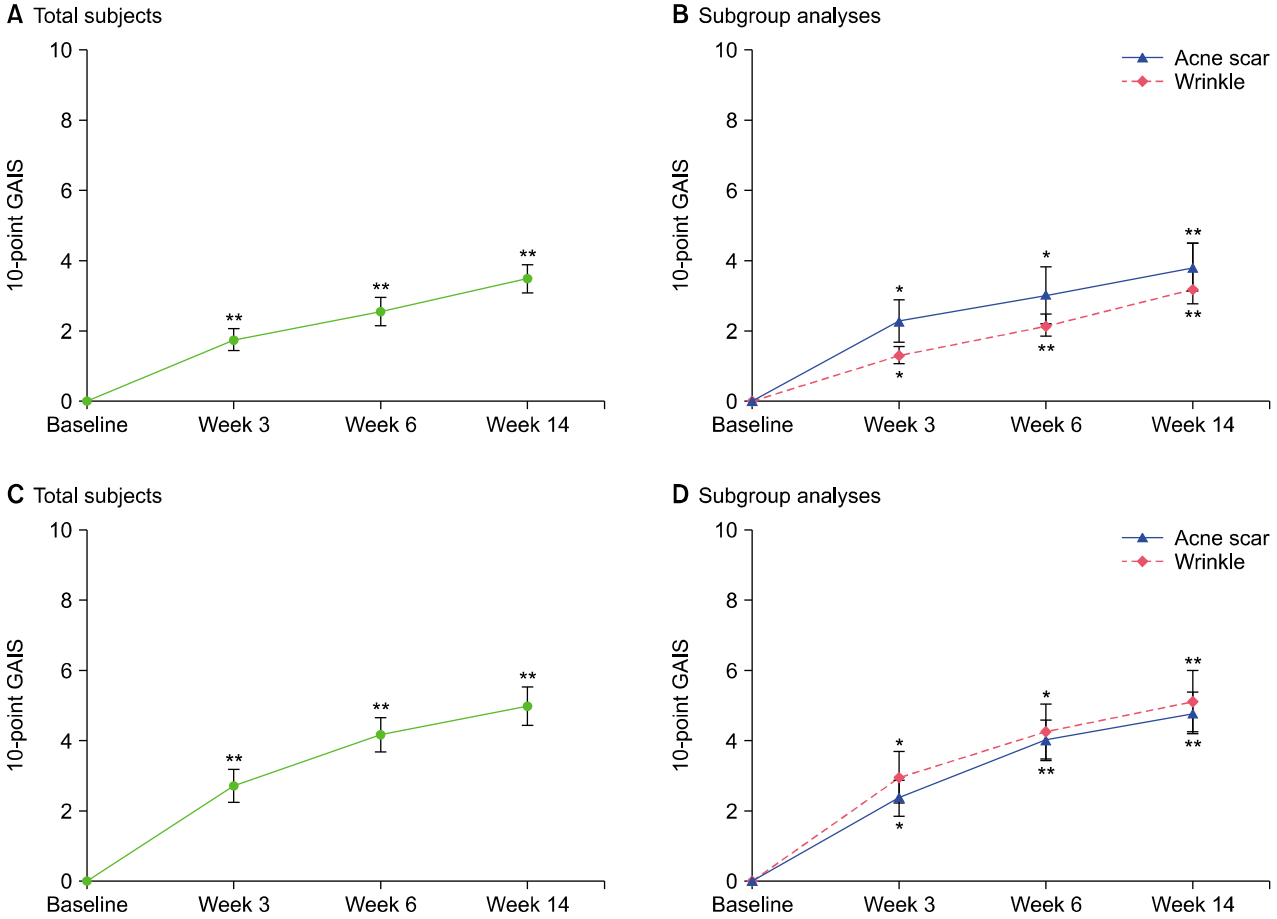

Fig. 1. (A, B) Mean improvement of global photographic assessment score of the three dermatologists. (A) Results of total subjects. (B) Subgroup analyses of subjects with acne scars and subjects with wrinkles. (C, D) Mean global assessment score of the subjects. (C) Results of total subjects. (D) Subgroup analyses of subjects with acne scars and subjects with wrinkles. Statistically significant improvements were observed after all treatment sessions and 2 months after the last treatment (week 14) compared to the baseline. GAIS: global aesthetic improvement scale. *$p<0.05$, compared to the baseline values; **$p<0.01$, compared to the baseline values.

4.0±1.64, and 4.8±1.79 at weeks 3, 6, week 14, respectively (Fig. 1D). All results were statistically significant compared to the baseline values; however, statistically significant differences were not noted between the two groups.

3) Profilometric measurement

Representative 2D and 3D digital photographs of subjects with wrinkles and subjects with acne scars taken by a specialized instrument (ANTERA 3D®) are shown in Fig. 2. The results of the profilometry parameters, including skin wrinkles, texture, depressions, and pores, measured using ANTERA 3D® are shown in Table 2. Compared to that at the baseline, most of the measured profilometry parameters showed significant improvement at week 14. When described the representative major indicators in detail, the maximum depth and indentation of the wrinkles significantly reduced by 14.05% ($p<0.01$) and 10.5% ($p<0.05$), respectively. In terms of the skin texture, the arithmetical mean roughness (Ra) decreased by 10.94% ($p<0.05$), and the squared mean roughness (Rq) decreased by 12.05% ($p<0.05$). The volume and maximum depth of skin depressions reduced by 23.81% ($p<0.05$) and 14.22% ($p<0.01$), respectively. The skin pores also showed significant improvement with respect to volume (decreased by 29.38%, $p<0.05$), maximum depth (decreased by 14.86%, $p<0.05$), number (decreased by 17.88%, $p<0.05$), and density (decreased by 17.88%, $p<0.05$).

4) Skin viscoelasticity

The gross elasticity (R2) significantly improved by 10.96% ($p<0.05$) in the overall subjects; 14.76%, subjects with wrinkles ($p<0.05$); and 6.39%, subjects with acne scars ($p<0.05$) (Fig. 3A). Significant differences were not noted between the two groups. With respect to net elasticity (R5), a significant improvement was observed only in sub-

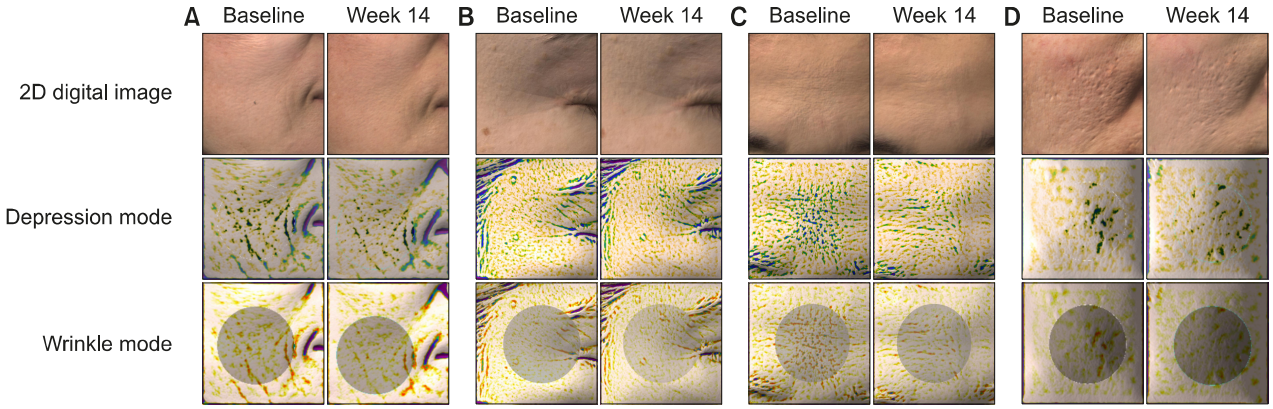

Fig. 2. Representative two-dimensional (2D) and three-dimensional (3D) digital photographs of (A～C) subjects with wrinkles and (D) subjects with acne scars taken by ANTERA 3D® at week 14. Compared to that at baseline, the subjects with wrinkle presented with reduced wrinkles and skin depression (A～C). Representative photographs of subjects with acne scars show reduced scar counts, depth, and affected areas (D).

Table 2. Percent change in the profilometric measurements at week 14

Subject group	Wrinkles	Acne scars	Overall subjects
Profilometry measurement (%)			
Wrinkles			
⊿Indentation	−9.53±8.84*	−11.66±12.16*	−10.50±10.27*
⊿Maximum depth	−9.90±12.68*	−19.01±12.52*	−14.05±13.15**
Texture			
⊿Roughness: Ra	−9.28±10.51*	−12.93±14.80*	−10.94±12.46*
⊿Roughness: Rq	−10.75±10.99*	−13.60±14.08*	−12.05±12.26*
⊿Elevation span	−7.65±24.52	−12.31±12.00	−9.77±19.55
Depressions			
⊿Volume	−23.58±28.70*	−24.08±36.71	−23.81±31.77*
⊿Maximum depth	−10.02±12.56*	−19.27±12.58*	−14.22±13.14**
⊿Affected area	−21.71±27.5*	−20.14±34.18*	−21.0±29.90*
Pores			
⊿Volume	−29.74±47.94*	−28.94±41.99*	−29.38±44.27*
⊿Maximum depth	−14.23±14.36*	−15.62±20.72*	−14.86±17.11*
⊿Count	−18.58±34.07*	−17.05±32.23*	−17.88±32.46*
⊿Density	−18.57±34.09*	−17.05±32.24*	−17.88±32.48*

Values are presented as mean±standard deviation. This data represents the relative value depicting the percentage change from baseline. *$p<0.05$, **$p<0.01$ compared to the baseline values.

jects with acne scars (improved by 7.91%, $p<0.05$) (Fig. 3B). The skin firmness (R7) improved by 9.04% ($p<0.05$) in the overall subjects; 9.73%, subjects with wrinkles ($p<0.05$); and 8.21%, subjects with acne scars ($p<0.05$) (Fig. 3C). In brief, the gross elasticity and skin firmness improved significantly in all groups, and the net elasticity improved significantly only in the subjects with acne scars.

Evaluation of the safety profile

The post-treatment adverse events were limited to erythema, pruritus, petechiae, pustules, and papules (Table 3). All subjects were satisfied with the treatment and did not complain of pain or discomfort. During the three-treatment session, transient erythema was the most common adverse event reported in ≥90% of the subjects after each treatment, and it spontaneously resolved in 1～3 days without treatment. Pruritus was reported in approximately 70% to 80% of the subjects and appeared 2～3 days after treatment and persisted for an average duration of 2 days. The other adverse events were petechiae (approximately 60% of the subjects), pustules (approximately 10%～20% of the subjects), and papules (approximately 0%～5% of the subjects), and these resolved acutely without lasting sequelae. Post-inflammatory hyperpigmentation, a major

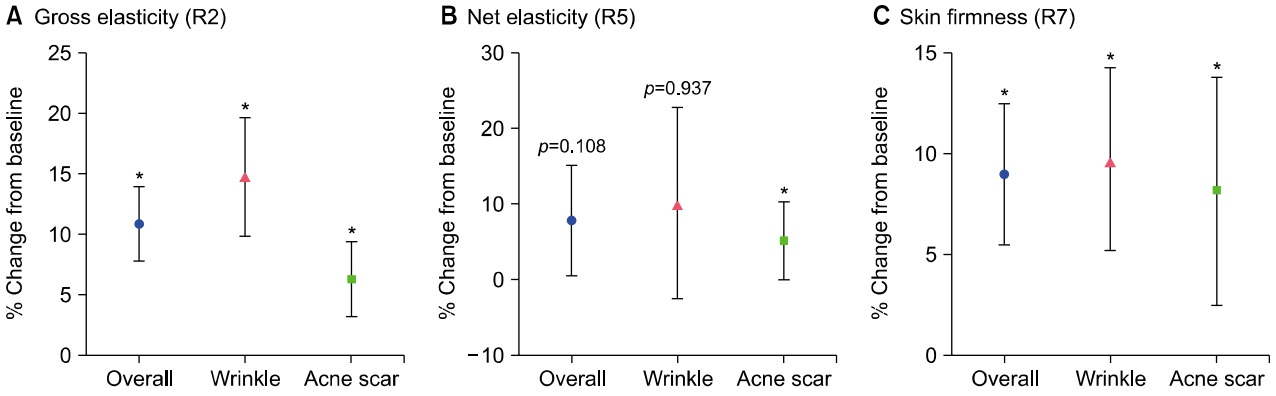

Fig. 3. Skin viscoelasticity as measured using Cutometer® at week 14. The gross elasticity (R2) (A) and skin firmness (R7) (C) significantly improved in all subjects. However, the net elasticity (R5) (B) showed significant improvement in only subjects with acne scars. *$p<0.05$, compared to the baseline values.

Table 3. Summary of the adverse events

Adverse event	After the first laser treatment	After the second laser treatment	After the third laser treatment
Erythema	22 (100)	20 (90.9)	22 (100)
Transient	20 (90.9) (17/3/0)†	20 (90.9) (12/8/0)†	22 (100) (13/9/0)†
Persistent	2 (9.1) (0/2/0)†	0	0
Pruritus	19 (86.4)	16 (72.7)	17 (77.3)
Transient	15 (68.2) (10/5/0)†	13 (59.1) (9/4/0)†	16 (72.7) (14/2/0)†
Persistent	4 (18.2) (1/3/0)†	3 (13.6) (1/2/0)†	1 (4.5) (0/1/0)†
Petechiae	13 (59.1)	14 (63.6)	13 (59.1)
Transient	10 (45.5) (9/1/0)†	11 (50.0) (8/3/0)†	13 (59.1) (10/3/0)†
Persistent	3 (13.6) (2/1/0)†	3 (13.6) (2/1/0)†	0 (0)
Pustules	12 (54.5)	5 (22.7)	5 (22.7)
Transient	7 (31.8) (5/2/0)†	4 (18.2) (4/0/0)†	3 (13.6) (2/1/0)†
Persistent	5 (22.8) (4/1/0)†	1 (4.5) (1/0/0)†	2 (9.1) (0/2/0)†
Papules	0 (0%)	1 (4.5)	0 (0)
Transient	0	1 (4.5) (1/0/0)†	0
Persistent	0	0	0

Transient adverse events resolved in 1 to 3 days; persistent adverse event persisted for >3 days. Values are presented as number (%) or number only. †Indicates (mild/moderate/severe case number).

concern in East Asians, and serious or unexpected adverse events were not observed. All these reactions showed mild to moderate severity, and the adverse events were self-limited. The frequency of adverse events was similar after each treatment session.

DISCUSSION

This study revealed that the fractional 1064-nm picosecond Nd:YAG laser with a DOE is effective and safe for the treatment of facial wrinkles and acne scars. Two months after the last treatment (at week 14), the mean GAIS score of 22 subjects was 3.5 points, corresponding to approximately 35% clinical improvement compared to the baseline (Fig. 1A). On the other hand, the subjects' self-assessment score was 5.1 points, corresponding to approximately 51% clinical improvement (Fig. 1C). All of mean improvement scores recorded by the subjects were higher than those recorded by the dermatologists. This finding may be because the subjects were satisfied with the laser treatment outcomes; therefore, they made favorable assessments. Moreover, objective profilometric parameters, including the maximum depth of the wrinkles, depression and pores, and skin viscoelasticity parameters, including gross elasticity and skin firmness, also showed significant improvement.

The clinical improvement presented in this study showed outcomes comparable with those reported in previous studies. Yim et al.[12] conducted a split-face comparative study on the treatment of facial wrinkles and pores using the picosecond 1,064-nm Nd:YAG laser with a MLA and quasi-long-pulsed 1,064-nm Nd:Yag laser. After five treatment cycles, in the Pico-arm, 54.2% and 12.5% of the subjects showed at least moderate improvement with respect to the visible pores and wrinkles, respectively, compared to 41.7% and 4.2% in the Quasi-arm group. The specific parameters of the Pico-arm were a spot size of 8 mm; fluence, 0.6~0.8 J/cm^2; pulse duration, 450 ps; and repetition rate, 10 Hz. With respect to the acne scars, Kwon et al.[13] reported a split-face clinical trial comparing a picosecond 1,064-nm Nd:YAG laser with a DOE and a non-

ablative 1,550-nm erbium-glass laser. Twenty-five subjects received four consecutive sessions of picosecond laser treatment at 3-week intervals; the treatment parameters were, as follows: spot size, 10 mm; fluence, 0.13～0.43 J/cm^2; repetition rate, 5～10 Hz; and pulse duration, 450 ps. The picosecond laser-treated subjects showed significantly better improvement in the acne scars (ECCA [échelle d'évaluation clinique des cicatrices d'acné] percent reduction: 55% vs. 42%) with less severe pain (4.3 vs. 5.6). The histological analysis revealed elongation and increased density of neo-collagen fibers, elastin fibers, and mucin throughout the dermis on both sides. Another study reported clinical and histological improvement in acne scars using a fractional 1,064-nm Nd:YAG picosecond laser with a DOE with the following parameters: fluence of 0.28～0.35 mJ/cm^2 and pulse duration of 450 ps[16]. The subjects underwent three treatment sessions 1 month apart. The average improvement in the ECCA score was 57.9%. Only petechiae were observed after treatment, and other side effects were not reported. Histological analysis revealed superficial cystic cavitation and markedly increased fragmentation of the collagen fibers at 30 minutes after treatment and increase in amount of elastin fibers and collagen fibers at 1 month after treatment. These histological changes were considered laser-induced optical breakdown (LIOB) induced by exposure to the picosecond fractional laser.

LIOB is considered the main morphologic change occurring in the epithelial layer on administration of fractionated picosecond laser treatment[8]. Histologically, LIOB presents as multiple microscopic intradermal cavities without injury to the dermo-epidermal junction or stratum corneum or ablative tissue damage to the skin surface[8,17]. The cavitation bubbles may generate shock waves that cause tissue damage and induce a tissue repair process wherein the cell signaling pathways for increasing neocollagenesis and neoelastinogenesis are triggered[18]. This phenomenon may account for the efficacy and safety of skin rejuvenation treatment, such as the treatment of wrinkles and acne scars with picosecond laser with a DOE. A similar phenomenon related to the photomechanical effect of a picosecond laser beam, known as the "bubble-like cavitation phenomenon" has also been observed at the subcellular level in the dermal cells laden with tattoo pigment[19]. A study reported that the chromophore, which absorbs the energy of the picosecond laser beam, is melanin, and the degree of LIOB depends on the melanin index and absorbed energy[20]. However, the major chromophore in the dermis has not been identified as only a small amount of melanin is present in the dermis. Hence, we speculated that the water-rich post-capillary venules in the upper dermis are among the target chromophore candidates.

In this study, the adverse events noted were erythema, pruritus, petechiae, pustules, and papules. Most of the adverse events were mild. Though adverse events of moderate severity were reported in some cases, they showed transient clinical features, which spontaneously resolved within 1 to 3 days. In cases of moderate degree of pruritus and folliculitis-like pustules, administration of oral antihistamine and anti-acne antibiotics (minocycline), respectively, for 2 to 3 days may be helpful.

Among the adverse effects, the distinctive feature was a high frequency of pruritus and petechiae; these adverse events are rarely reported with other types of non-ablative laser treatment. Another study reported that petechiae developed in 36% of the subjects treated with a fractional picosecond laser and not in those treated with conventional non-ablative fractional lasers[13]. Accordingly, pruritus and petechiae are characteristically observed following picosecond fractional laser treatment and may develop in response to capillary rupture and leakage of plasma in the upper dermis due to exposure to high peak energy of the picosecond laser. The leaked plasma percolated into the dermal interstitial space or microcavities resulted from LIOB may contain platelets, red blood cells, and several growth factor molecules, such as basic fibroblast growth factor (bFGF), platelet-derived growth factor (PDGF), transforming growth factor-β (TGF-β), and platelet-activating factor (PAF)[21,22]. Pruritogens, such as PAF in the leaked plasma, may lead to the development of characteristic pruritus. Some growth factors present in the leaked plasma or those obtained from the tissue regeneration process could aid in dermal regeneration.

There were some limitations of this study. First, this study did not have a control arm. Second, the sample size was small. Third, all subjects had a similar ethnic background; hence, the findings could not be generalized. Fourth, the long-term efficacy was not evaluated. However, we think that this study is important as we objectively evaluated several indicators systematically.

In conclusion, a favorable clinical improvement in the facial wrinkles and acne scars was observed on treatment with the fractional 1,064-nm picosecond laser with a DOE, as denoted by the results of the physicians' and subjects' assessments and by evaluation of the objective parameters, including profilometric parameters and skin viscoelasticity. The treatment was safe as we did not observe serious and unexpected side effects or considerable pain. Thus, the fractional 1,064-nm picosecond laser is an effective and safe therapeutic modality for skin rejuvenation. Further large-scale controlled comparative trials will

be necessary to establish optimal treatment parameters for various indications.

SUPPLEMENTARY MATERIALS

Supplementary data can be found via http://anndermatol.org/src/sm/ad-33-254-s001.pdf.

CONFLICTS OF INTEREST

The authors have nothing to disclose.

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DATA SHARING STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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