Effectiveness of a Fractional Picosecond 1,064-nm Laser in Improving Traumatic Scars with Depression

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The picosecond laser has been widely used to remove tattoos, and improve wrinkles, acne scarring, and pigmented scars. This study was performed to investigate the efficacy and safety of a 1,064-nm fractional picosecond laser treatment for depressed traumatic scars. A total of twenty Korean patients with depressed scars were treated with a 1,064-nm fractional picosecond laser at a two-week interval with a spot size of 3 mm, fluence of 3.5 to 5.5 J/cm², and frequency of 2 Hz with a combination of microlens arrays. At 4 weeks after the final treatment, there was a statistically significant improvement in the modified Vancouver Scar Scale (mVSS) and the patient satisfaction score without any significant complication. A 1,064-nm fractional picosecond laser treatment is a safe and effective method to improve traumatic wound scars with depression.

Key words

Picosecond laser; Depressed scar; Traumatic wound; Pitted scar; Microlens array

Received December 5, 2020
Accepted December 17, 2020

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INTRODUCTION

In 2012, the picosecond 755-nm alexandrite laser was first approved for removal of tattoos by US FDA, and it has shown better outcome than the traditional nanosecond quality switched (Q-switched) lasers.¹ Not only for removing tattoos, the picosecond laser has been widely used in treatment of wrinkles and acne scarring. During the treatment, the laser energy could be absorbed by target melanocytic lesions, leading photomechanical effect causing fragmentation of the pigmentation without damaging the surrounding normal soft tissue. In picosecond laser, it deliver lower fluence of energy, leading to fewer adverse response than nanosecond laser.²

In our prior study, we found that the 1,064 nm fractional picosecond laser treatment has shown dramatic result in improving scars with pigmentation.³ Furthermore, we found the improvement of modified Vancouver Scar Scale after the picosecond laser treatment, especially in the depression of scar. According to our experience, we described our clinical experience of effectiveness of picosecond laser treatment for facial scars with remarkable depression.

MATERIALS AND METHODS

Patients

Twenty Korean patients with depressive traumatic scars (age range: 5-61 years old, mean age: 44.1 years old) were enrolled in this study. Patients with matured scars at suture site after traumatic injuries such as laceration and animal bites, were included. All of patients had no significant familial or medical history. Patients' medical charts and procedure records were reviewed retrospectively to evaluate the outcomes and complications after the procedures. This study complied with the protocols and regulations of institutional review board (IRB) and was performed according to the criteria set by declaration of Helsinki. All written informed consents were obtained from each patient for both picosecond laser treatment and publication of photographs of the result.

Picosecond laser treatment

All patients were applied a topical 5% lidocaine anesthetic ointment (Emla®; AstraZeneca AB, Karlskoga, Sweden) in the target area for laser treatment. After 30 minutes to 1 hour of application, patients washed off the ointment with mild soap and water immediately before the laser session.

The patients were received 3 to 5 sessions (mean: 3.8

sessions) of 1,064-nm fractional picosecond laser (PICO-CARE®; WONTECH, Daejeon, Korea) at a two-week interval with a spot size of 3 mm, fluence of 3.5 to 5.5 J/cm², and frequency of 2 Hz in combination of microlens array. The average of total laser shot per session was 737.5 (range, 398-1004). All the patients were educated to avoid direct sunlight and use a broad-spectrum of sunscreen agent between the following laser sessions.

Evaluation of outcomes

The patients were photographed on the day of treatment before the procedure, and 1 month after the final session. The clinical assessment for the degree of improvement was evaluated by physicians was performed 1 month after the last session by analyzing the clinical photographs of the patients with modified Vancouver Scar Scale (Table 1). All patients evaluated their degree of satisfaction about current status of the scars with 4-point scale (0, not satisfied; 1, dissatisfied; 2, satisfied; and 3, extremely satisfied) before and after 4 weeks of treatment.

Statistical analysis

Statistical analyses were performed using SPSS version 20.0 (SPSS Inc., Chicago, IL, USA). Wilcoxon signed-rank test was used to compare the modified Vancouver Scar Scale and patients' satisfaction scores before and after the picosecond laser treatment. The results were expressed as the mean ± standard deviation. In all analy-

Table 1. Modified Vancouver Scar Scale

Vascularity	
Normal	0
Pink	1
Red	2
Purple	3
Pigmentation	
Normal	0
Hypopigmentation	1
Hyperpigmentation	2
Pliability	
Normal	0
Supple	1
Yielding	2
Firm	3
Ropes	4
Contracture	5
Depression	
Flat	0
< 1 mm	1
1-2 mm	2
2-3 mm	3
> 3 mm	4

ses, p -value of less than 0.05 was taken to indicate statistical significance.

RESULTS

The mean modified Vancouver Scar Scale for the treated scars was 9.89 ± 1.37 before treatment, and it was 5.11 ± 1.37 4 weeks after last treatment. There were statistically significant different between before and after laser treatment ($p < 0.05$). All values of modified Vancouver Scar Scale showed remarkable improvement after the laser treatment (Fig. 1). Especially in the depression of scar, it was statistically significantly decreased before and after treatment (3.16 ± 0.69 vs 1.11 ± 0.46 , $p < 0.05$).

The mean patients' satisfaction scores was 1.00 ± 0.82 before treatment. It increased to 2.47 ± 0.51 4 weeks after picosecond laser treatment (Fig. 2). This result was statistically significant ($p < 0.05$).

DISCUSSION

Since the first approval of picosecond laser by US FDA in removal treatment of tattoos, the picosecond laser has been utilized to treat various skin trouble including wrinkle, and acne scarring. Brauer et al investigated the safety and efficacy of a 755-nm picosecond laser treatment for facial acne scarring.⁴ This research showed remarkable improvement of acne scarring, including elevation of depressed scars, by presenting histologic findings about remodeling of collagen in target area.

The main mechanism of fractional picosecond laser in

leading regeneration of collagen and soft tissue at target site is based on laser-induced optical breakdown (LIOB). Melanocytes at the epidermal zones absorb the energy concentrated by microlens array and free electrons are generated and released. Then these free electrons absorb the laser light again and the second free electrons are generated. This sequence of chain reaction of generating free electrons resulted in ionized plasma formation. As a result, a vacuole is created at the epidermal layer, causing cavitation phenomenon. By forming cavitation in the epidermal and dermis layer, the fractional picosecond laser treatment can release the contracted collagen fibers and this cavitation lead additional collagen, elastic tissue and mucin regeneration.^{5,6}

The depression type of scar is the most complex problem confronting plastic surgeon and dermatologist. Many efforts have been tried to improve the depressive scars, but still there is no gold standard for this fastidious wound problem. Traditionally, many physicians used subcision technique at sunken scars to release the scar tissue. Described by Spangler et al. first, it is a method of cutting soft tissue under the depressed scar using fine needle inserted under the skin.⁷ The mechanism of subcision technique is by cutting contracted collagen and fibromuscular attachments beneath the pitted scar. Also, controlled trauma cause by fine needling can promote regeneration of new connective tissue underneath the defect with collagen regeneration.⁸

Laser-induced optical break down effect induced by fractional picosecond laser could make lots of vacuoles under the depressed scars in epidermal and dermal layer, which is similar to the mechanism of subcision.

Fig. 1. The mean modified Vancouver Scar Scale decreased from 3.16 ± 0.69 to 1.11 ± 0.46 after picosecond laser treatment. All categories of scar scale showed statistically significant reduction ($p < 0.05$).

Fig. 2. The mean patients' satisfaction score increased from 1.00 ± 0.82 to 2.47 ± 0.51 after picosecond laser treatment. The difference was statistically significant ($p < 0.05$).

In our study, mean modified Vancouver Scar Scale of the scars was significantly improved after laser sessions, and this improvement was especially dramatic at the depression category. Our patients showed dramatic color improvement and elevation of depressed scar after sequences of fractional picosecond laser treatment with

microlens array tip (Fig. 3-5). By removing and releasing fibrous strand beneath the depressed scar like subcision technique, fractional picosecond laser could prompt scar elevation and promote collagen remodeling phase in the target area, resulting more aesthetic results in patients' satisfaction score. Furthermore, there was a depressed

Fig. 3. (A) The baseline appearance showed pigmented and depressed scar beneath right eyebrow. Improvement in texture and depression in 2 weeks (B) and 4 weeks (C) of picosecond laser treatment.

Fig. 4. (A) The baseline appearance showed pigmented and depressed scar at both cheek and chin caused by dog. (B) Improvement in pigmentation and depression after 6 weeks of picosecond laser treatment.

Fig. 5. (A) The baseline appearance showed pigmented and depressed scar beneath right eyebrow. Improvement in discoloration and depression in 2 weeks (B) and 4 weeks (C) of picosecond laser treatment.

wound case caused by triamcinolone injection for keloid treatment. Intra-lesional triamcinolone injections have been used to treat hypertrophic scar, but it could make dermal atrophy in surrounding normal tissue by lymphatic spread.⁹ Fractional picosecond laser treatment was also effective in this depressed scar caused by dermal atrophy following triamcinolone injection. Further histologic evaluation for the subcision effect of vacuole cause by picosecond laser treatment and collagen regeneration would be expected in the next study.

CONCLUSION

In this study, all of the 20 patients with depressive traumatic scars were achieved the good improvement in modified Vancouver Scar Scale and patients' satisfaction score after 1,064-nm fractional picosecond laser treatment. There were no significant side effects including edema, petechial, cellulitis, or burn except mild pain during the laser treatment. We suggest the 1,064-nm fractional picosecond laser treatment is a safe and effective method for depressive traumatic scars.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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How to cite this article: Ahn KH, Park ES, Choi CY. Effectiveness of a fractional picosecond 1,064-nm laser in improving traumatic scars with depression. *Med Lasers* 2020;9:179-183. <https://doi.org/10.25289/ML.2020.9.2.179>