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ORIGINAL RESEARCH REPORT

# Efficacy and safety of 1550-nm fractional laser in the treatment of acne scars in Chinese patients: A split-face comparative study

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**ABSTRACT**

**Objective:** To evaluate the efficacy and side effects of 1550-nm fractional Er:Glass laser in treating atrophic acne scar. **Materials and methods:** Thirty Chinese patients aged 18–65 with atrophic acne scars on both cheeks received a split-face treatment, one side with four sessions of treatment with fractional 1550-nm Er:Glass laser at 20-day interval and the other with topical asiaticoside cream application three times daily as control. Clinical response and side effects were evaluated by a dermatologist three weeks after each treatment and again 12 weeks after the last laser treatment. In addition, self-evaluation of satisfaction by the patients was done at the end of treatment. **Results:** The study found that mean scores decrease after treatment was $5.65 \pm 4.34$ for the treated side and $1.23 \pm 3.41$ for the control side. The improvement in acne scars after the fractional Er:Glass laser 1550-nm treatment was more significant than the control side ($p = 0.0001$). The side effects were mainly local skin irritation and erythema, which disappeared within one week. **Conclusion:** The research results show that the fractional 1550-nm Er:Glass laser is an effective and safe treatment device for atrophic acne scars.

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**KEYWORDS**
1550 nm; atrophic acne scars; non-ablative fractional laser

## Background

Acne has a prevalence of 90% in adolescents (1). It often leads to atrophic scar formation. In addition to causing undesirable cosmetic appearances, atrophic scars can lead to considerable psychosocial impairment and affect quality of life. There is a wide variety of medical and surgical modalities for the treatment of atrophic acne scars, including chemical peeling, punch excision, fat or filler injection, subcision surgery, microneedling, laser resurfacing, and dermabrasion (2,3). While many methods have been shown to improve acne scars, the side effects such as aggravation of scarring, prolonged erythema, and dyspigmentation often make them unsatisfactory.

Since 1990 s, ablative lasers such as the ultrapulse $CO_2$ laser and erbium YAG laser have been used for the treatment of atrophic scars. Although improvements in scars can be achieved with these lasers, they are usually associated with complications (4) such as persistent pigmentation, prolonged erythema, and even worsening of scarring, limiting the application of these lasers in Asian skin. Since 2003, fractional laser (FL) has come into use based upon the concept of fractional photothermolysis (5). It creates evenly distributed microscopic photothermal wounds (called micro thermal zones, or MTZ), leaving the peripheral skin tissue intact (6,7). Because of this unique design (8–10), FL can stimulate the wound-healing response and in turn neocollagenesis with rapid regeneration of epidermis (11,12). Therefore, such adverse effects as hyperpigmentation and delayed erythema are greatly reduced.

There are two types of FLs, ablative and non-ablative, depending on the wavelength and energy of the laser involved. Ablative FLs (e.g., $CO_2$ and ER:YAG lasers) have been demonstrated to be effective in the treatment of atrophic acne scars (13,14), but they can also cause hyperpigmentation, delayed erythema, and significant downtime, especially in Asian skin (15). In contrast, non-ablative FLs have fewer such side effects (16), though they are less effective than ablative FLs (17). The Er:Glass (1550 nm) FL was the earliest such laser to be used for atrophic scar treatment. There have been reports of treatment of acne scars with non-ablative FLs with varied results, including in Asian people (18,19). However, there have been few well-designed, controlled, prospective studies to evaluate the efficacy of atrophic scar treatment with this kind of FL. Therefore, we have conducted a prospective randomized split-face, evaluator-blinded clinical study on Chinese patients to assess the efficacy and safety of 1550-nm FL for the treatment of atrophic acne scars in Chinese patients.

## Materials and methods

This is a randomized, split-face, evaluator blind, prospective clinical study. Thirty Chinese patients aged 18–65 with atrophic

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acne scars on both cheeks were enrolled in the study. Patients signed an informed consent form for participation in the study. Exclusion criteria were 1) presence of other skin diseases; 2) history of surgical operation, chemical peeling or dermabrasion, injection, photodynamic therapy, or other treatments that may affect the efficacy evaluation in the treated area within one year; 3) patients with allergic diseases, porphyria, or allergy to the experimental drug; 4) immune deficiency, or long-term use of corticosteroids or immunosuppressant; 5) presence of severe systemic disease; 6) drugs or other systemic treatment for acne scar within four weeks before treatment; 7) local treatment of acne scars within the past two weeks; 8) pregnancy or lactation; and 9) tanning within four weeks before treatment. The IRB of Huashan Hospital, Fudan University, approved the study protocol, which conformed to the ethical guidelines of the 1975 Declaration of Helsinki.

Upon enrollment, each patient was assigned a random number to decide which side of the patient's face is to be treated using a fractional 1550-nm Er:Glass device (GP900B, Shenzheng GSD Technology Co. Ltd). The other side of the face served as control, treated with topical asiaticoside cream (Shanghai Shyndec Pharmaceutical Co. Ltd). Photographs of the patients were taken before each treatment and at each subsequent visit. The energy of the laser used in this study ranged from 18 to 22 mJ, with the density being 150 MTZ/cm$^2$. In total, eight passes of treatment were performed within one session and icepack was used to alleviate pain. Altogether four sessions of fractional photothermolysis treatment were conducted for each patient at 20-day intervals. After laser treatment, patients were asked to avoid sun exposure and to use sunscreen cream.

As for the control side of patient's face, asiaticoside cream was applied three times a day until 20 days after the final laser treatment.

Clinical evaluation of both sides of face was done before laser treatment, three weeks after laser treatment, and 12 weeks after the last laser treatment, according to the condition of the acne scars of the time. A dermatologist blinded to the treatment status of the patients evaluated the outcomes according to Table 1.

The evaluation criteria of clinical response of laser treatment are as follows:

Good: the score decreased more than 50%
Effective: the score decreased by 25–50%
No effect: the score decreased less than 25%

Total effective rate = (The number of patients with "Good" + the number of patients with "effective")/total patients number ∗100%

As for the safety evaluation, we recorded the side effects, including erythema, dyspigmentation, infection, and scar formation, at each follow-up visit.

In addition, after the whole treatment session, patients were asked to evaluate their satisfaction with the treatment outcome and safety on a 4-point scale (Very good, Good, Medium, or Inadequate).

The data were recorded as means ± standard deviations. Statistical analysis was conducted using the paired-samples *t*-test for comparison of the effectiveness and side effects at a significance level of 0.05.

## Result

Twenty-six of thirty patients completed the whole treatment session. Four patients withdrew from the study: Two of them due to too long downtime and the other two due to personal reasons. There was no statistically significant difference between the treated and control side in terms of original scar scores and history of treatment.

Mean decrease in the scores of acne scars after treatment was 5.65 ± 4.34 on the fractional Er:Glass laser-treated side ($t = 6.64$, $p < 0.0001$) and 1.23 ± 3.41 for the control side ($S = 19.50$, $p = 0.0938$), and the difference between the two sides was statistically significant ($Z = 3.81$, $p = 0.0001$). Mean improvement rate was 36.5 ± 23.81% for the laser-treated side ($t = 7.82$, $p < 0.0001$) and 7.12 ± 19.11% for the control side ($S = 18.00$, $p = 0.1182$), and the difference between the two sides was statistically significant as well ($Z = 4.16$, $p < 0.0001$).

In this study, the total effective rate of treated side was higher than that of the control group (Figure 1). As shown in Table 2, after treatment with the fractional Er:Glass device (the treated side), 8 patients (30.77%) had improvement that was rated as "good," 8 (30.77%) rated as "effective," and 10 (38.46%) rated as "no effect" by the physician, the total effective rate being 61.54%. In contrast, the percentage of good, effective, and no effect results on the control side was 3.85, 15.38, and 80.779%, respectively, the total effective rate being 19.23%. There was a significant difference between the treated and control sides ($p = 0.002$).

As for the patient self-evaluation, three patients (11.54%) rated their satisfaction as very good, 11 (42.31%) rated as good, and 8 (30.77%) rated as medium in the treated side. In contrast, one patient (3.85%) rated his or her satisfaction as very good, 5 (19.23%) rated as good, and 2 (7.69%) rated as medium in the control side.

**Table 1.** Evaluation table (20).

| Type | No. of lesion (1–10) | No. of lesion (11–20) | No. of lesion (> 20) |
|---|---|---|---|
| Light: 1 score for each erythema or pigmentation<br>Mild disk-like atrophic scar | 1 | 2 | 3 |
| Moderate: 2 scores for each<br>Moderate disk-like atrophic scar<br>Hole-like, shallow atrophic scar with diameter < 5 mm<br>Shallow, large atrophic scar | 2 | 4 | 6 |
| Severe: 3 scores for each hole-like, deep but normal atrophic scar with diameter < 5 mm<br>Hole-like, deep and abnormal atrophic scar with diameter < 5 mm<br>Linear or ditch-like dermal atrophic scar<br>Deep, large atrophic scar | 3 | 6 | 9 |

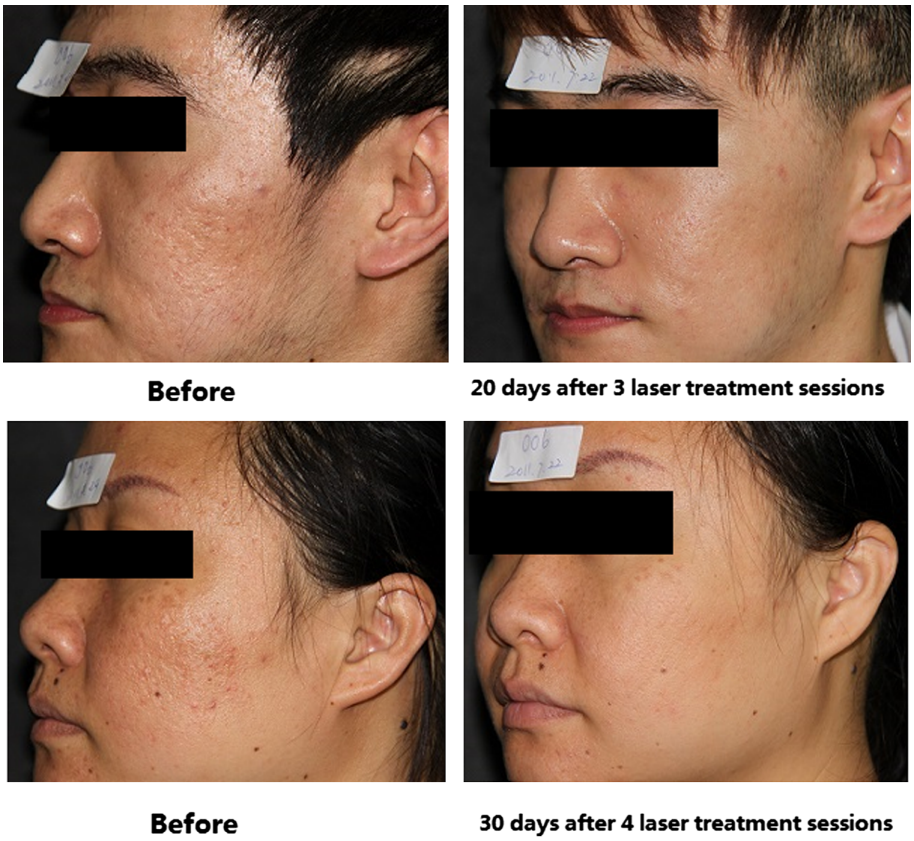


**Figure 1.** The photos of patients before and after treatment.

The result of self-evaluation was similar to that of physician's evaluation, with the treated side achieving significantly better improvement ($p = 0.0012$).

The difference of clinical efficacy between the male and female did not have statistical significance ($T = 148.5$, $p > 0.05$). Age had a negative correlation with scar improvement ($b = -0.403$, $p = 0.0102$). The percentage of the score decrease did not have significant correlation with the original severity ($t_b = 0.04$, $p = 0.9652$). As is shown in this research, the effect of duration of acne scar on clinical response was not statistically significant ($t_b = -2.03$, $p = 0.0531$). The age at onset ($t_b = -2.67$, $p = 0.0885$) and BMI ($t_b = -1.47$, $p = 0.1540$) also did not have any linear correlation with clinical efficacy either according to our study.

Among the 26 patients who completed the whole treatment session, there was no severe irreversible adverse event until the end of the treatment session, including blistering and scarring. Only one patient had transient hyperpigmentation five days after treatment, which disappeared two weeks later without any intervening treatment. The safety evaluation of treated side was not significantly different from the control side.

## Discussion

The fractional Er:Glass 1,550-nm laser is a type of non-ablative FL based upon the principle of fractional photothermolysis. This laser, instead of traditional laser resurfacing, can produce a group of evenly distributed MTZ that can reach deep into dermis with the peripheral skin tissue kept intact. Then post-traumatic wound healing was started, promoting the synthesis and remodeling of collagen fiber. After the healing process, the MTZ was replaced with new collagen (21), thus improving skin texture, laxity, and atrophic scars. Since the normal skin tissue surrounding MTZs was not damaged, which is pretty different from the traditional laser resurfacing or dermabrasion, re-epithelialization will be accomplished within 24 hours (22). Therefore, quick healing greatly decreases the risk and extent of such adverse effects as hyperpigmentation, delayed erythema, and even scar formation (Table 3).

Asiaticoside is a kind of gypenoside that is extracted from Umbelliferae *Centella asiatica*. It can promote the proliferation of fibroblasts and the synthesis of collagen during wound healing (23–25), thus having a certain therapeutic effect on atrophic acne scar.

**Table 2.** Physician's evaluation of efficiency.

| Item | Treated side | Control side | Corrected $X^2$ | *p* |
|---|---|---|---|---|
| Good | 8 (30.77) | 1 (3.85) | 9.67 | 0.002 |
| Effective | 8 (30.77) | 4 (15.38) | | |
| No effect | 10 (38.46) | 21 (80.77) | | |
| Total | 26 (100.00) | 26 (100.00) | | |

**Table 3.** Self-evaluation of efficiency.

| Item | Treated side | Control side | Corrected $X^2$ | *p* |
|---|---|---|---|---|
| Very good | 3 (11.54) | 1 (3.85) | 10.48 | 0.0012 |
| Good | 11 (42.31) | 5 (19.23) | | |
| Medium | 8 (30.77) | 2 (7.69) | | |
| Inadequate | 4 (15.38) | 18 (69.23) | | |
| Total | 26 (100.00) | 26 (100.00) | | |

This study was a randomized, split-face, and evaluator-blinded study. Twenty-six patients participated in the entire clinical trial, including twelve males and fourteen females, with twelve patients with the right side as control and fourteen patients with the left side as control.

With the increase in the number of 1550-nm FL treatment sessions, the clinical response of acne scar improved according to our investigation. The laser-treated side improved more significantly than the control side, according to both the dermatologist's evaluation and self-evaluation, and the difference was statistically significant ($p < 0.0001$). These results indicate that 1550-nm FL is effective for atrophic acne scar. In order to gain optional treatment outcome, multiple treatment is necessary.

Age might be one of the influential factors on clinical response, according to our study. Younger patients had better improvement than the elder patients, probably due to their better regeneration capacity. Gender, BMI, age at onset, duration of acne scar, and original scar severity did not seem to have significant correlation with clinical efficacy. However, further study is necessary based on a larger sample and long-term follow-up, and the conclusion will be more persuasive.

There is no doubt that the energy and MTZ density are important factors affecting the clinical response (26–29). The higher the energy, the better the treatment outcome and also the more the adverse effects (9,30). Lower-density treatment brings fewer side effects (29,31). A study (29) showed that clinical response might be positively correlated with MTZ density, but another article (31) claimed that low-density treatment is at least as effective as the high-density treatment. Therefore further study will be necessary. According to a study, MTZ density contributed more to adverse effects (32). Therefore, the energy of the laser used in this study was relatively high, while the density being relatively low in order to get better clinical response without much increase in side effects. To achieve better results, eight passes of treatment were used in our study, which also proved effective and safe for acne scar. Comparison of clinical response and adverse effects between different energy and density group is necessary based on a lager sample in further study.

No severe irreversible adverse effects occurred in any patient till the end of the treatment. Immediate adverse reactions were mainly skin irritation, erythema, and pain, which usually disappeared within one week. Topical anesthesia before laser treatment and cooling during the treatment can relieve the pain. Long-term side effects such as delayed erythema and hyperpigmentation were not seen in the patients who finished the study under the setting we used in our study. The lack of hyperpigmentation after laser treatment may be attributed to the fact that the patients enrolled were not photosensitive and were told to avoid sun exposure after treatment. What is more, we used non-ablative FLs, which usually have less adverse effects (16). Transient injury of skin barrier is possible after 1550-nm FL therapy, manifested as dry skin, pruritus, and increase of skin susceptibility to irritations. As a result, moisturizer and emollients are recommended after laser therapy. Moreover, it is important to avoid sun exposure in order to prevent hyperpigmentation, and sunscreen of SPF $\geq$ 30 and PA+++ is recommended.

## Conclusion

The research results show that atrophic acne scar improved after 1550-nm FL therapy and the adverse effects are minimal and reversible. Therefore, 1550-nm fractional Er:Glass laser is an effective and safe treatment device for atrophic acne scar.

## Declaration of interest

The authors report no other declaration of interest. The authors alone are responsible for the content and writing of the article.

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