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Research Article

Effectiveness of 730 nm Picosecond Laser for the Treatment of Freckles and Solar Lentigines: A Retrospective Analysis

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Background. Freckles and solar lentigines are epidermal pigmentation disorders that affect the face and impact the quality of life of affected individuals. *Aims*. We aimed to observe and evaluate the clinical effectiveness of a 730 nm picosecond laser for the treatment of freckles and solar lentigines. *Methods*. We retrospectively collected patient information on freckles and solar lentigines and observed and evaluated the clinical outcome of a 730 nm picosecond laser. These included lesion clearance and recurrence rates, adverse reactions, and patient satisfaction. *Results*. Fifty cases of freckles and solar lentigines reported between January 1, 2022, and July 1, 2022, were included. All patients received two 730 nm picosecond laser treatments. The lesion clearance rates after one and two treatments were 53.1% and 78.4%, respectively, and the rates after one and six months of treatment were 78.7% and 78.4%, respectively. 90% of the patients reported ≥95% clearance of lesions after six months via a questionnaire survey. Among the patients, 86.0% were satisfied with their treatment. Postinflammatory hyperpigmentation occurred in two patients, both of whom had Fitzpatrick skin type IV. There was no recurrence of lesions. *Conclusions*. The 730 nm picosecond laser treatment for freckles and solar lentigines has the advantages of a high clearance rate, low recurrence rate, and high patient satisfaction. This trial is registered with ChiCTR2200058573.

1. Introduction

Epidermal pigmentation disorders include solar lentigines and freckles [1]. Solar lentigines are irregular hyperpigmented macules and patch, with smooth surface and clear borders. The size of solar lentigines should not exceed 1 centimeter varying from 1 millimeter to 5 millimeters. Freckles are light brown spots with irregular but distinct borders [2]. Although they are related to sun exposure, they appear on chronically light exposed skin regions [3]. In contrast to solar lentigines, which tend to be distinctly pigmented year-round, freckles typically fades in color during winter [1, 4]. This has a negative impact on the quality of life of individuals [5]. Although solar lentigines and freckles have different pathophysiological origins, conventional treatment methods include Q-switched ruby, 755 nm nanosecond, and Q-switched 532 nm lasers [5–8]. These treatment methods have various adverse effects, such as pigmentation and a low lesion clearance rate [6–8]. However, recently commercialized picosecond (ps) lasers can selectively manage melanin and melanocytes [7, 8]. The application of ps lasers in hyperpigmented skin diseases has drawn increasing attention. With a pulse duration in the picosecond range, the ps-lasers has distinguishing characteristics. On the one hand, it utilizes a photomechanical effect to destroy the target tissue; on the other hand, it produces a weak photothermal effect, which allows less undesirable heat diffusion into the surrounding structures [9, 10].

The existing ps laser includes wavelengths of 532 nm, 755 nm, and 1064 nm. These have been widely used in the treatment of pigmented skin diseases such as freckles, solar lentigines, cafe-au-lait spots, nevus of Ota, tattoos, and other diseases. Recently, the 730 nm·ps laser has emerged as a novel development in this field, boasting a pulse width of only 250 ps—the shortest pulse width of all existing lasers.

This extremely short pulse width can effectively break up pigments in target tissues. Some literature has described cases in which the 730 nm·ps laser successfully treated freckles, solar lentigines, nevus of Ota, and tattoos, attesting to the effectiveness of this laser [11]. However, these studies were based on a limited number of case series, rather than systematic evaluations. In this clinical research, we performed the first retrospective systematic analysis of a 730 nm·ps laser for freckles and solar lentigines. Lesion clearance and recurrence rates, adverse reactions, and patient satisfaction were also evaluated. This is the first study to assess the effectiveness and safety of the 730 nm·ps laser.

2. Materials and Methods

2.1. Patient Information. We collected the ID number, name, age, sex, telephone number, outpatient medical records, and therapeutic plan. Furthermore, follow-up data were obtained for those patients who had reached the end of their treatment. All patients in our study were rigorously screened based on predetermined inclusion criteria. It is noteworthy that the severity of the patients' conditions prior to treatment did not influence the outcomes of our clinical study.

3. Methods

3.1. Patient Inclusion Criteria

(1) Patients diagnosed with freckles and solar lentigines from center from January 1, 2022, to July 1, 2022.

(2) Solar lentigines are irregular hyperpigmented macules and patch, with smooth surface and clear borders. The size of solar lentigines should not exceed 1 centimeter varying from 1 millimeter to 5 millimeters. Freckles are light brown spots with irregular but distinct borders.

3.2. Patient Exclusion Criteria. The patient exclusion criteria are as follows:

(1) Have received other related treatments in the past six months, such as laser and injection therapy

(2) Complicated by other pigmented disorders such as melasma, sebaceous keratosis, and nevus fusco-caerules zygomaticus

(3) Complications of other systemic diseases, such as hypertension and diabetes.

3.3. Treatment Methods. All patients signed informed consent prior to treatment. Standardized photographs were taken before treatment and at the six-month posttreatment follow-up. A 730 nm·ps laser (PicoWay, Candela, Weyland, USA) was applied after administering the topical anesthetic cream. The treatment parameters were set at 1.5–1.8 J/cm^2, 1 Hz, and 250 ps. Ice bags were applied for 40 min immediately after ps laser treatment. The number of lesions was recorded prior to treatment, and from these, the lesion clearance rate was calculated. A lesion clearance rate of >75% was considered the endpoint of the treatment. Laser treatment was applied only to those areas of the patient's face where skin lesions were present. The interval between treatments was one month. Patients were advised to exercise diligent sun protection during the treatment period.

3.4. Clinical Efficacy Evaluation. The results were interpreted by three independent cosmetic dermatologists. The evaluation of clinical efficacy was based on both objective and subjective assessments of lesion clearance at various time points following the completion of treatment.

3.4.1. Subjective Assessment. Lesion clearance rate: poor response 1 score (0–24% clearance); minimal response 2 score (25–49% clearance); good response 3 score (50–74% clearance); excellent response 4 score (75–94% clearance); complete remission 5 score (≥95% clearance) [12, 13].

3.4.2. Objective Assessment. The number of freckles and solar lentigines was recorded according to photography before each treatment. The skin lesion clearance rate was calculated by comparing the lesion number changes before and after treatment [13].

3.5. Adverse Reaction and Patient Satisfaction. The adverse reactions included lesion recurrence, hyperpigmentation, and hypopigmentation. Patient satisfaction was assessed using the Lesion Improvement Rating Scale. Very satisfied 5 score; satisfied 4 score; slightly satisfied 3 score; dissatisfied 2 score; very dissatisfied 1 score [13].

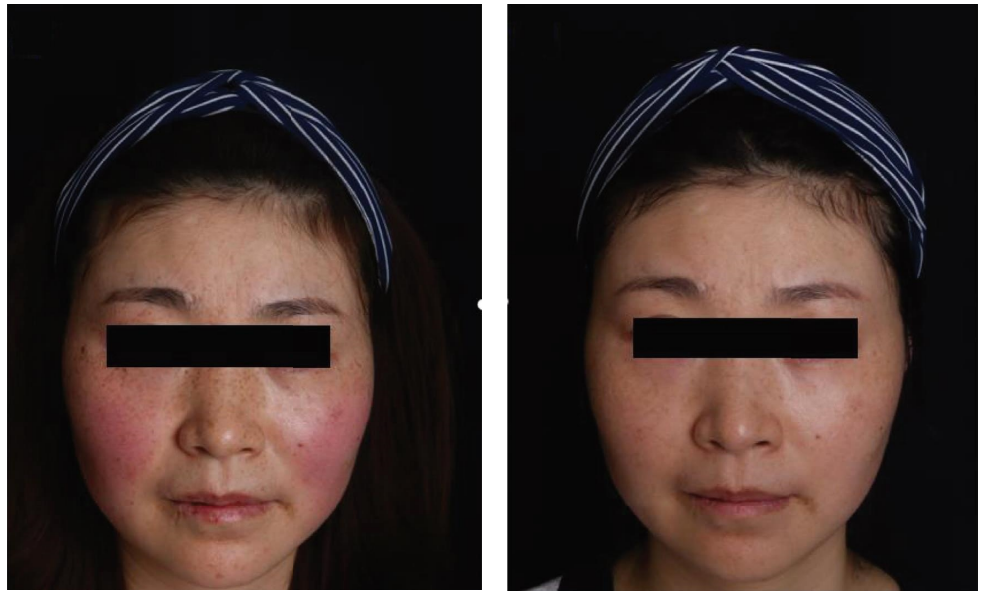
4. Results

4.1. Patient Information. Fifty cases of freckles and solar lentigines from January 1, 2022, to July 1, 2022, which met the inclusion criteria, were included in this study. The participants comprised 45 (90.0%) women and 5 (10.0%) men with a mean age of 32.0 years. All 50 patients had Fitzpatrick skin types III-IV. They each received two treatments with the 730 nm·ps laser.

4.2. Clinical Efficacy

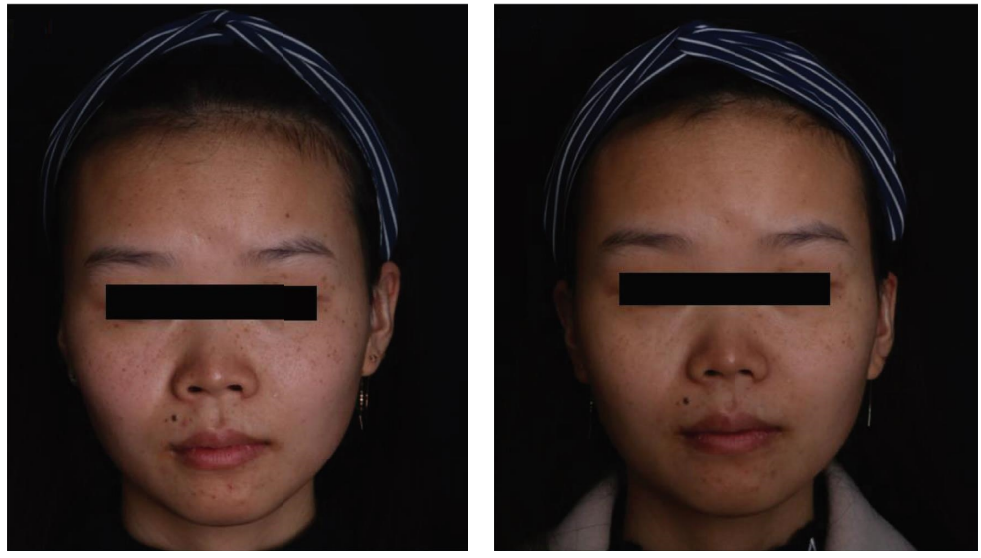
4.2.1. Subjective Assessment. The patients were asked to complete questionnaires after six months. One patient (2%) was assessed as 1 (poor), two (4%) as 3 (good), two (4%) as 4 (excellent), and the remaining (90%) of the patients were assessed as 5 (complete).

4.2.2. Objective Assessment. The lesion clearance rate after one and two treatments were 53.1% and 78.4%, respectively, and those after one and six months of treatment were 78.7% and 78.4%, respectively (Figures 1–4).



(a) (b)

Figure 1: Photographs of changes of solar lentigines on the face of a participant. (a) Solar lentigines on the face before treatment. (b) One month after two sessions of treatments.



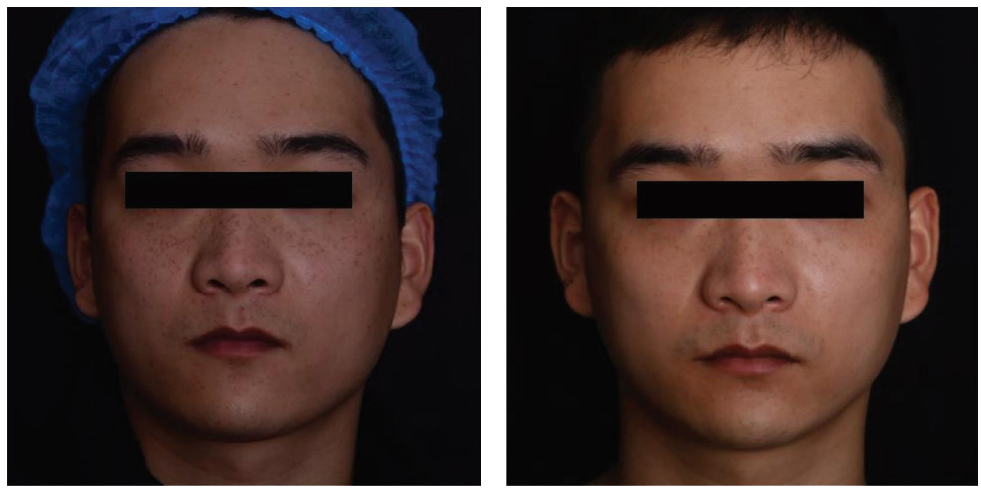
(a) (b)

Figure 2: Photographs of changes of freckles on the face of a participant. (a) Freckles on the face before treatment. (b) One month after one session of treatment.

4.3. Adverse Reaction and Patient Satisfaction. There was no recurrence of lesions. Transient adverse responses included immediate erythema and edema. Postinflammatory hyperpigmentation appeared in two patients, both of whom had Fitzpatrick skin type IV. All patients signed patient satisfaction questionnaires after six months. One patient (2%) scored 1 (very dissatisfied), six cases (12%) scored 3 (slightly satisfied), twelve cases (24%) scored 4 (satisfied), and the rest (62%) scored 5 (very satisfied). Out of the participants, 43 (86.0%) patients expressed satisfaction with the treatment, while 7 (14.0%) were not satisfied. The dissatisfaction in the latter group was primarily due to postoperative pigmentation in two patients, and four patients felt that the lesion clearance did not meet their expectations.

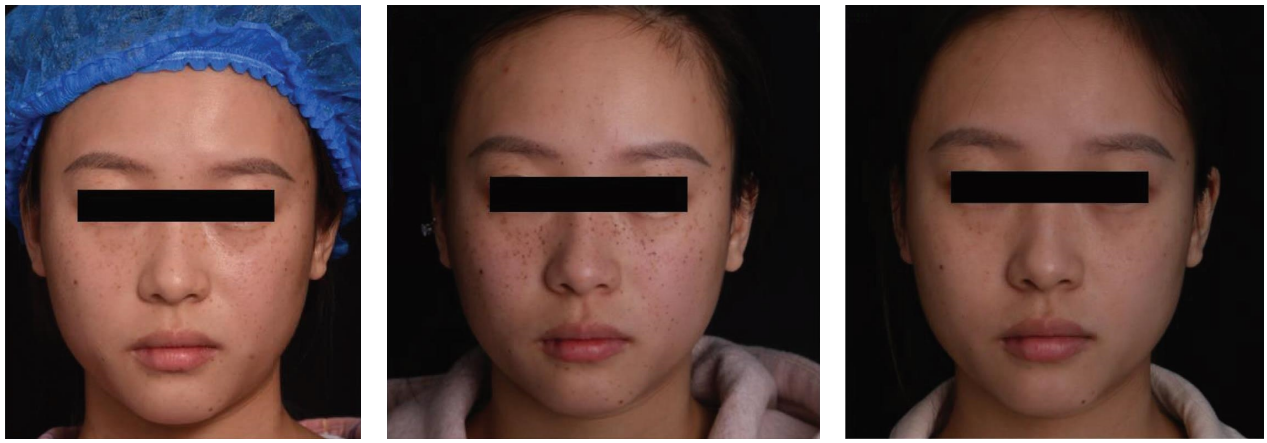
5. Discussion

Current methods for treating freckles and solar lentigines encompass various laser technologies, including Q-switched 532 nm lasers, Q-switched ruby laser, 755 nm nanosecond



(a) (b)

Figure 3: Changes of freckles recorded by a single-lens reflex camera at baseline and 6 months. (a) Freckles on the face before treatment. (b) Six month after two sessions of treatments.



(a) (b) (c)

Figure 4: Photographs of changes of freckles recorded by a single-lens reflex camera of a representative participant. (a) Freckles on the face before treatment. (b) Seven days after one session of treatment. (c) Six months after two sessions of treatment.

laser, Nd: YAG 1064-nm lasers, 532 nm·ps laser, and 755 nm·ps laser [5–8]. Potential adverse responses to these treatments may include immediate erythema, edema, hyperpigmentation, and hypopigmentation. The KTP 532-nm laser had the highest occurrence rate of postinflammatory hyperpigmentation. The risk after treatment in hyperpigmented lesions can be observed in approximately 25% of darker skin types [5]. Hu et al. reported that approximately 5.6% developed transient hyperpigmentation with the alexandrite 755 nm ps laser [10]. The Q-switched ruby laser had been proven effective in treating solar lentigines and freckles due to a wavelength of 694 nm and pulse durations of 25–40 nanoseconds [14]. The degree of undesirable postinflammatory hyperpigmentation may change depending on level of fluence applied and the skin type. A wavelength of 1064 nm can penetrate deeper into the dermis, thereby minimizing the absorption of epidermal melanin. Therefore, the Q-switched Nd: YAG 1064 nm laser treatment is less effective for freckles and solar lentigines than other Q-switched laser wavelengths [15].

Ps lasers have shorter pulse widths, which were different from Q-switched lasers, laser energy emitted by ps lasers in the shorter ps domains likely generates an photomechanical effect with a tensile strength that exceeds the ultimate tensile stress of the tissue when targeting pigmented chromophores, which lead to tissue fracture and ablation [7, 11, 12]. One study discovered that the satisfaction scores of patients were significantly higher when treated with the 532 nm ps laser, even though there was no significant difference in the clearance of solar lentigines between the 532 nm ps laser and 532 nm nanosecond lasers [16]. The 730 nm·ps laser is viewed as a novel method for the selective treatment of pigmentary diseases [11]. This 730 nm·ps Ti: sapphire laser is generated by converting the 532 nm second harmonic of the

primary 1064 nm PSL into 730 nm laser light, utilizing a laser-pumped laser handpiece. Lee et al. reported success in treating two Asian patients with freckles, lentigines, and melasma using this novel 730 nm ps laser. A significant reduction in pigmentation was achieved with just one treatment session. Both subjects showed clinical improvement, with the best results observed for the treatment of freckles such that 95% of the lesions achieved excellent response (75–94% lightening) [11]. In another study by Kauvar et al., sixteen subjects with a total of 118 discontinuous treatment areas underwent treatment with a 730 nm·ps-domain laser four times, and the mean improvement for all treatment areas was 51%–75% clearance [17]. It is important to note that these results are primarily derived from case series.

In our study, we had evaluated the effectiveness and safety of 730 nm·ps laser treatment for freckles and solar lentigines. The lesion clearance rates after one and two treatments were 53.1% and 78.4%, respectively. The lesion clearance rates after one month and six-month end of treatment were 78.7% and 78.4%, respectively. These results suggest that two 730 nm·ps laser treatments can help achieve a lesion clearance rate of >75%. There was no recurrence of lesions. Similarly, Lin Tong found that the average lesion clearance for the 730 nm·ps laser was $68.99 \pm 7.42\%$, a rate comparable to that of the 755 nm·ps alexandrite laser ($69.27 \pm 7.75\%$). Furthermore, the same research indicated that patients perceived the 730 nm·ps laser to be less painful than the 755 nm variety, even though there was no significant difference in lesion clearance between the two ($p = 0.34$) [18]. In our study, the patients confirmed that the downtime for 730 nm·ps laser treatment was short. Transient erythema and edema were observed immediately after treatment; however, they subsided within 30 min after immersion in ice. Postinflammatory hyperpigmentation appeared in two patients, both of whom had Fitzpatrick skin type IV, topical application of hydroquinone accelerated remission. Notably, 86.0% of the cases expressed satisfaction with the treatment.

6. Conclusions

In conclusion, we believe 730 nm·ps laser treatments exhibit a high clearance rate, low recurrence rate, and high patient satisfaction. Our results suggest that patients with type III-IV Fitzpatrick skin tend to prefer this treatment. Nonetheless, this study has its shortcomings: on the one hand, this is a relatively subjective evaluation index on account of some outcomes which were obtained through rating scale. In future studies, some objective evaluation indexes need to get more valuable results. On the other hand, a larger sample and a longer follow-up should be established to verify our view in future. Additionally, the application and advantage of 730 nm·ps laser in further study in the treatment of pigment skin diseases are required.

Data Availability

All the data generated or analyzed in relation to this study are included within the article.

Ethical Approval

The study has been approved by the Ethics Committee of Chengdu Second People's Hospital (2022055), and Chinese Clinical Trial Register Number: ChiCTR2200058573.

Consent

Informed consent was obtained from all participants involved in the study.

Conflicts of Interest

The authors declare no conflicts of interest.

Authors' Contributions

Qilei Che wrote the original draft, edited the manuscript, and supervised the study. Qingbiao Wa supervised the study. Lufeng Liu, Qiuyue Tang, Yulian Gao, and Jie Lu curated the data. Zixuan Zhou and Yuhong Xie performed the software analysis.

Acknowledgments

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