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Clinical Efficacy and Safety Analysis of 308nm Excimer Ultraviolet Light Combined with Carbon Dioxide Fractional Laser in the Treatment of Refractory Vitiligo

Gang Li*

Department of Dermatology and Venereology, Suining County People's Hospital, Xuzhou 221200, Jiangsu Province, China

***Corresponding author:** Gang Li, no.lg10@163.com

Abstract: This paper aims to explore the clinical effect and safety of combined application of 308nm excimer ultraviolet light and carbon dioxide fractional laser in the treatment of refractory vitiligo. The study was carried out from January 2020 to December 2022. 60 patients with refractory vitiligo were selected and divided into the study group (n = 30) and the control group (n = 30) through the lottery method of medical record envelopes. The patients in the control group were treated with 308nm excimer ultraviolet light, and the patients in the study group were treated with 308nm excimer ultraviolet light combined with carbon dioxide fractional laser treatment. The clinical effective rate, leukoplakia area, IgG level, and incidence of adverse reactions were compared between the two groups. The clinical effective rate of the study group was higher than that of the control group ($P < 0.05$). After treatment, the leukoplakia area of the study group was lower than that of the control group ($P < 0.05$), and the IgG level of the study group was lower than that of the control group ($P < 0.05$). The incidence of adverse reactions in the study group was lower than that in the control group ($P < 0.05$). The combined application of 308nm excimer ultraviolet light and carbon dioxide fractional laser therapy for patients with refractory vitiligo has a significant effect, can reduce the area of leukoplakia and IgG levels, and has high treatment safety, which can be widely applied in clinical practice.

Keywords: 308nm excimer ultraviolet light; Carbon dioxide fractional laser; Vitiligo

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1. Introduction

Melanin is the pigment in the skin, which can determine the skin color. If the skin melanocytes are destroyed, it can lead to the lack of melanin, white spots on the skin tissue, and vitiligo. Vitiligo can occur in multiple parts of the body. White patches of different sizes can be seen in the skin tissue of patients. Some patients are accompanied by inflammatory lesions such as tinea corporis and eczema. Vitiligo can affect the patients' appearance and normal social interaction, so early treatment is needed [1,2]. The routine clinical treatment of vitiligo is 308nm excimer ultraviolet light. Its main mechanism of action is to kill T lymphocytes, induce the

synthesis of melanin, and reduce the area of leukoplakia [3]. Patients with refractory vitiligo have a long course of disease, and long-term use of 308nm excimer ultraviolet light cannot obtain satisfactory curative effect. Some studies believe that combined application of carbon dioxide fractional laser can achieve ideal therapeutic effect [4]. In this study, 60 samples of patients with refractory vitiligo were selected to explore the clinical value of combined application of 308nm excimer ultraviolet light and carbon dioxide fractional laser treatment.

2. Materials and methods

2.1. General information

The sample selection and research process of this study were approved by the Medical Ethics Committee. The study was carried out from January 2020 to December 2022. 60 samples of patients with refractory vitiligo were selected and divided through the lottery method of medical record envelopes into study group (n = 30) and control group (n = 30). In the study group, there were 17 males and 13 females, with an age range of 33–58 years, with an average of 45.58±3.06 years old. The skin lesions included face and neck in 11 cases, extremities in 9 cases, and trunk in 10 cases. In the control group, there were 18 males and 12 females, with an age range of 35–57 years old, with an average of 45.63±2.98 years old. The skin lesions included 12 cases on the face and neck, 9 cases on the extremities, and 9 cases on the trunk. The general data of the two groups were comparable (P > 0.05).

Inclusion criteria were patients that meet the diagnostic criteria for refractory vitiligo in the Consensus on Vitiligo Diagnosis and Treatment, patients without other skin tissue lesions, and those that signed the research consent document.

Exclusion criteria included patients that recently received vitiligo treatment, contraindications for ultraviolet radiation therapy, patients complicated with major organ diseases such as liver and kidney.

2.2. Methods

The patients in the control group were treated with 308nm excimer ultraviolet light, by using the hospital's 308nm ultraviolet light skin therapy instrument. The doctor observed the patient's skin lesions, pointed the device at the skin lesion area, and determined the initial irradiation energy (300mJ/cm^2 for the limbs, 200mJ/cm^2 for the trunk, and 100mJ/cm^2 for the face). During the treatment period, the irradiation energy intensity was adjusted appropriately, once a week, for a total of 3 months.

The patients in the study group received 308nm excimer ultraviolet light combined with carbon dioxide fractional laser therapy, and the carbon dioxide fractional laser therapy was given priority. The treatment power was set to 15W, the wavelength was 10.6μm, the pulse width was 0.5ms, and the initial treatment energy was 30mJ/cm^2. During the treatment period, the spot size and energy intensity were adjusted according to the skin condition, and treatment was done once a month for a total of 3 months. After carbon dioxide fractional laser treatment, 308nm excimer ultraviolet light was performed, and the treatment plan was the same as that of the control group.

2.3. Evaluation criteria

The clinical effectiveness of the two groups was evaluated after 3 months of treatment. If the skin color is normal after treatment and the leukoplakia disappears, it is considered cured. If the lesion area is reduced by more than 60% after treatment, and the leukoplakia is significantly reduced, it is considered effective. If it does not meet the standards of "cured" and "effective," it is ineffective. The leukoplakia areas of the two groups were counted before treatment, after 1 month of treatment, and after 3 months of treatment. Venous blood samples

were collected from patients in the two groups before treatment, after 1 month of treatment, and after 3 months of treatment, and IgG levels were detected by enzyme-linked immunosorbent assay. Statistics on the incidence of adverse reactions in the two groups of patients was determined.

2.4. Statistical methods

SPSS23.0 software was used to analyze the research data, measurement data (±s) was *t* test, count data % was χ^2 test, $P < 0.05$ indicated that there was a statistical level difference.

3. Results

3.1. Comparing the clinical effectiveness

As shown in **Table 1**, the clinical effective rate of patients in the study group was higher than that in the control group ($P < 0.05$).

Table 1. Comparison of clinical effective rates between the two groups (n/%)

Group	Cured	Effective	Ineffective	Total effective rate
Study group (n = 30)	21	7	2	28 (93.3)
Control group (n = 30)	15	7	8	22 (73.3)
χ^2 value	-	-	-	4.320
P value	-	-	-	0.037

3.2. Comparing the areas of leukoplakia

As shown in **Table 2**, after treatment, the leukoplakia area of the study group was lower than that of the control group ($P < 0.05$).

Table 2. Comparison of leukoplakia area between the two groups (±s, cm^2)

Group	Before treatment	1 month after treatment	3 months after treatment
Study group (n = 30)	17.49±2.75	11.42±2.04	7.12±1.03
Control group (n = 30)	17.55±2.68	14.69±3.85	10.38±1.96
t value	0.086	4.111	8.064
P value	0.932	0.000	0.000

3.3. Comparison of IgG levels

As shown in **Table 3**, after treatment, the IgG level of patients in the study group was lower than that in the control group ($P < 0.05$).

Table 3. Comparison of IgG levels between the two groups (±s, mg/L)

Group	Before treatment	1 month after treatment	3 months after treatment
Study group (n = 30)	4.75±1.02	3.05±0.62	2.17±0.65
Control group (n = 30)	4.79±0.96	3.99±1.05	3.19±0.94
t value	0.156	4.222	4.888
P value	0.876	0.000	0.000

3.4. Comparison of the incidence of adverse reactions

As shown in **Table 4**, the incidence of adverse reactions in the study group was lower than that in the control group ($P < 0.05$).

Table 4. Comparison of the incidence of adverse reactions between the two groups (n/%)

Group	Scab	Swelling	Itchiness	Blisters	Incidence of adverse reactions
Study group (n = 30)	1	1	0	0	2 (6.7)
Control group (n = 30)	3	3	1	2	9 (30.0)
χ^2 value	-	-	-	-	5.454
P value	-	-	-	-	0.019

4. Discussion

The main pathological feature of vitiligo is the destruction of melanocytes in the skin tissue, and the lack of melanin in the patient's skin tissue leads to the formation of leukoplakia in the skin tissue. The causes of the disease are heredity, immune system disease, neurochemical substances, etc. White patches of different sizes can be seen in the skin tissue of the patient, accompanied by tinea corporis-like and eczema-like inflammatory lesions, and can produce itching and other symptoms [5,6]. Vitiligo can affect the aesthetics of the patient's face and neck, and can lead to psychological problems in patients, for which early intervention is required.

308nm excimer ultraviolet light is a routine clinical treatment for refractory vitiligo. Its main function is to induce the apoptosis of activated T cells in the skin lesion area, effectively remove the infiltrating T lymphocytes in the skin area, and activate pseudoperoxidation. Hydrogenase induces the synthesis of vitamin D3, thereby accelerating the proliferation of melanocytes, increasing the level of melanin in skin tissue, reducing the area of leukoplakia, and effectively relieving related symptoms [7,8]. Long-term application of 308nm excimer ultraviolet light to patients with refractory vitiligo can produce plateau phenomenon, and increasing the treatment energy cannot effectively relieve related symptoms. The thickness of the skin tissue increases significantly, resulting in a decrease in the penetration of ultraviolet light which affects the therapeutic effect. Carbon dioxide fractional laser is based on the traditional carbon dioxide pulse laser treatment plan, adding computer graphics generator and other equipment, which can accurately treat the depth and avoid damage to the dermis [9]. Fractional carbon dioxide laser therapy can form tiny treatment holes on the skin surface, induce the migration of melanin in peripheral cells, promote the secretion of growth factors and cytokines, accelerate the division and proliferation of melanocytes, and reduce the area of leukoplakia [10]. Fractional carbon dioxide laser therapy can effectively remove superficial epidermal tissue and excessively thick stratum corneum in the lesion area, improve the penetration of ultraviolet light, avoid the plateau period of 308nm excimer ultraviolet light, and improve the treatment effect [11].

The combination of 308nm excimer ultraviolet light and carbon dioxide fractional laser treatment has a significant effect on patients with refractory vitiligo, which can reduce the vitiligo area. This may be because 308nm excimer ultraviolet light has a strong penetrating power, which can induce the apoptosis of T lymphocytes in the skin lesion area, induce the synthesis of vitamin D3, block the production of cytokines, accelerate the proliferation of melanocytes, and then reduce the area of leukoplakia. Carbon dioxide fractional laser treatment can form vertical microscopic treatment holes in the leukoplakia area of the skin tissue, resulting in damage to the barrier function of the skin tissue, allowing 308nm excimer ultraviolet light to penetrate the epidermal tissue, increasing the total amount of local energy absorption, and strengthening the therapeutic

effect [12]. Fractional carbon dioxide laser therapy can also inhibit the synthesis and secretion of inflammatory factors, regulate the function of the immune system, restore the balance of T cells, and increase the level of melanocytes, thereby reducing the area of leukoplakia and improving the treatment effect of the disease [13]. The results of this study showed that IgG levels in the study group were lower than those in the control group after treatment. Analysis shows that tyrosinase is a typical oxidase, and its main function is to regulate melanin synthesis. The combination of IgG and tyrosine in the human body can produce an immune response, which in turn affects the synthesis of melanin, leading to an increase in the area of leukoplakia and hindering the recovery process of patients. During the treatment of refractory vitiligo, it is necessary to control the IgG level, increase the activity of tyrosinase, and increase the synthesis of melanin to improve related symptoms [14]. The combined application of 308nm excimer ultraviolet light and carbon dioxide fractional laser treatment can achieve synergy between the two treatment options, induce T cell apoptosis *in vivo*, reduce IgG levels, increase tyrosine activity, and increase melanin synthesis. The results of this study show that the incidence of adverse reactions in the study group is lower than that in the control group. The reason is that long-term application of 308nm excimer ultraviolet light can lead to increased skin thickness and hyperkeratosis, which can easily induce adverse reactions in skin tissues. Combined with carbon dioxide fractional laser treatment, it can remove excessively thick stratum corneum, and can ensure that the treatment accuracy is limited to the superficial layer of the skin and effectively protect the dermis, thus the treatment is relatively safe [15].

In summary, the combined application of 308nm excimer ultraviolet light and carbon dioxide fractional laser treatment for patients with refractory vitiligo has a significant effect. It can reduce the leukoplakia area and IgG levels, and has high treatment safety, which can be a valuable treatment option.

Disclosure statement

The author declares no conflicts of interest.

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