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REVIEW

Applications of Long-Pulse Alexandrite Laser in Cosmetic Dermatology: A Review

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Abstract: The long-pulse alexandrite laser uses Cr^{3+}:$BeAl_2O_4$ crystals as the activation medium and has a 755nm wavelength and millisecond pulse duration. The long-pulse alexandrite laser has been utilized for hair removal, vascular lesions, pigmented lesions, and other conditions because melanin and hemoglobin in the skin, subcutaneous tissues, and skin appendages can specifically absorb this type of laser. To serve as a guide and source of inspiration for the clinical use of this type of laser, we review the present research status and advancement of the long-pulse alexandrite laser in the treatment of the aforementioned categories of disorders.

Keywords: long-pulse alexandrite laser, hair removal, vascular lesions, pigmented lesions

Introduction

The long-pulse alexandrite laser generates a laser with a wavelength of 755nm and pulse duration that typically surpasses milliseconds using Cr^{3+}:$BeAl_2O_4$ crystals as the activation medium. It is currently frequently used in medical cosmetology, and aesthetic dermatologists prefer it. The principle of selective photothermolysis is the foundation for the growth of laser cosmetology.[1] According to this theory, when the proper laser parameters are chosen by the biological traits of various tissues, the target tissues' absorption coefficient of laser light is greater than that of normal tissues, allowing for the destruction of the target tissues while minimizing damage to normal tissues, realizing the unity of the effectiveness and safety of laser treatment.

Long-pulse alexandrite lasers are mostly used today for treating vascular lesions, pigmented lesions, and hair removal. In hair removal, melanin in the hair follicle and hair shaft particularly absorbs the light energy emitted by the long-pulse alexandrite laser and converts it into heat energy, damaging the hair follicle and accomplishing the goal of hair removal. The long-pulse alexandrite laser, when used to treat vascular lesions, largely causes hemoglobin-mediated thermal destruction to the diseased blood vessels. Additionally, long-pulse alexandrite lasers can increase the formation and growth of pigmented lesions by decomposing the melanin in the pigmented area through focused heating and excreting it through human metabolism. Furthermore, by heating the melanin in the pigmented areas to break it down and expel it from the body through metabolism, long-pulse alexandrite lasers achieve the purpose of treating pigmented lesions.

The advantages of wavelength and pulse duration of the long-pulse alexandrite laser, which enable it to penetrate to a certain depth and be absorbed by hemoglobin and melanin in the skin, subcutaneous tissues, and skin appendages, and thus safely and adequately heat the target tissue, suggest that it has the potential to treat a wide range of diseases. This article reviews the therapeutic developments made possible by long-pulse alexandrite lasers in the treatment of vascular lesions, pigmented lesions, and hair removal. It is the first review regarding applications of long-pulse alexandrite laser in cosmetic dermatology.

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Long-Pulse Alexandrite Laser in Hair Removal

The wavelength and pulse duration of a long-pulse alexandrite laser has a direct impact on its ability to remove hair. On the one hand, because of its relatively long 755nm wavelength, it can reach the melanin-rich hair follicles by penetrating the epidermis. The melanin in the hair follicle, on the other hand, has a stronger selective absorption property when compared to the hemoglobin in the blood vessels surrounding the dermis, which not only ensures the depth of the treatment but also lowers the incidence of redness, swelling, subcutaneous bleeding, and other side effects. The long-pulse alexandrite laser's pulse duration is longer than the thermal relaxation time of the epidermis and extremely close to the thermal relaxation period of the hair follicle, providing the best possible results in terms of destroying the hair follicle and sparing the surrounding tissues.[2,3] The sector of hair removal has seen the most use of the long-pulse alexandrite laser since it was originally introduced in 1997,[4] both for cosmetic and therapeutic objectives.

For Cosmetic Purposes

According to two retrospective studies, both individuals with light skin tones (Fitzpatrick skin types II, III) and those with dark skin tones (Fitzpatrick skin type IV) can successfully remove unwanted hair with the long-pulse alexandrite laser. For individuals with light complexion, the average hair removal rate was around 81%, while for those with dark skin, it was around 88%. It is common to think of mild erythema or edema surrounding the hair follicle as the treatment's endpoint because it typically goes away on its own in a few hours to a few days. The likelihood of side effects including hyperpigmentation and hypopigmentation, which are typically benign and treatable, is less than 4.5%.[5,6] Additionally, hyperpigmentation is more frequent in people with darker skin types, which may be due to epidermal melanin's competitive absorption of light energy.

According to two more prospective trials, the long-pulse alexandrite laser with sapphire handpiece produced an average hair reduction of more than 91% across the body in 65 patients with Fitzpatrick skin types II–VI. In contrast to the face, groin, and legs, axillary hair showed the best outcomes for hair removal. All patients, with the exception of brief perifollicular erythema, did not encounter any side effects such as hyper- or hypopigmentation.[7,8] Both studies proposed that the sapphire handpiece's cooling system, which balances energy distribution and lowers epidermal temperature, may be responsible for the enhanced treatment outcomes and decreased adverse effects.

For Therapeutic Purposes

When aberrant hair development causes an inflammatory response in the skin and its appendages that interferes with daily life, therapeutic hair removal is required.

After shaving, weak follicular walls allow exposed hair shafts to re-enter the skin, causing inflammatory papules and pustules known as pseudofolliculitis barbae (PFB). In a randomized, double-blind, split-face trial, Leheta[9] examined the efficacy of long-pulse alexandrite laser and intense pulsed light (IPL) in the treatment of patients with PFB. The outcomes showed that after just 7 treatments, the long-pulse alexandrite laser-treated side had reduced the number of papules and hair density by nearly 80%. The hair removal rate on the IPL-treated side was around 30% lower for the same number of sessions than it was for the long-pulse alexandrite laser. The number of treatments must be increased by three to five in order to have the same effects. Additionally, following the long-pulse alexandrite laser treatment, the recurrence cycle is longer and the recurrence region is less. Leheta speculates that the reason for this difference may have something to do with the fact that the long-pulse alexandrite laser delivers energy more consistently and efficiently, destroying more hair follicles.

Acne keloidalis nuchae (AKN) shares a lot of similarities with PFB in terms of its pathogenic process. An early intervention with a long-pulse alexandrite laser proved successful in preventing the onset of AKN, according to a prospective research involving 17 patients with the condition. All patients demonstrated considerable softening of the lesions after six treatments, with a mean reduction in papule and pustule counts of 90% and 98%, respectively, and a reduction in keloidal plaque size of 54.5%. Furthermore, there were no recurrences in any of the patients during the follow-up, which the study highlighted may be directly related to the absence of new hairs or the inability of new, fine, soft hairs to penetrate the skin following hair removal.[10]

Fradet et al[11] discovered that mild to moderate hidradenitis suppurativa (HS) during the hair growth period might be successfully treated with a long-pulse alexandrite laser. This is because laser hair removal damages hair follicles while also indirectly destroying sebaceous glands at the site of the lesion. The best follicle destruction effect can be obtained by administering the long-pulse alexandrite laser treatment during the hair growth period when the melanin content is at its peak. Applying the long-pulse alexandrite laser during the other cycles is less effective in destroying the follicles and is more likely to cause inflammation.

Curly hair shafts may cause keratosis pilaris (KP),[12] which is characterized by the presence of follicular plugs, which not only lessens the smoothness of the skin but also causes itching, erythema, and other inflammatory symptoms. KP is caused by damage to the epithelium of the hair follicle. In the therapy of these disorders, the long-pulse alexandrite laser has produced good results. According to a prospective randomized controlled trial, the long-pulse alexandrite laser prompts dermal collagen thickening in KP patients to lessen skin roughness and inflammation, with 25% reduced erythema in the laser group compared to the control group. Moreover, the long-pulse alexandrite laser is more effective than the 810nm diode laser for treating erythema in KP patients, and it is more comfortable than the Q-switched (QS) neodymium:yttrium–aluminum–garnet (Nd:YAG) laser and fractional CO_2 laser.[13]

Long-Pulse Alexandrite Laser in Vascular Lesions

The melanin in the epidermis has a lower absorption coefficient for the 755nm wavelength compared to oxyhemoglobin, reducing the side effects caused by the competitive absorption of melanin and further enhancing the therapeutic effect of the long-pulse alexandrite laser on vascular lesions, even though the 755 nm wavelength is not close to the three main absorption peaks of oxyhemoglobin (418, 542, and 577 nm). A list of application of long-pulse alexandrite laser in vascular lesions can be seen in Table 1.

Table 1 Application of Long-Pulse Alexandrite Laser in Vascular Lesions

Author	Aim	Parameters	Outcomes
Su et al[14]	Infantile Hemangioma	Pulse duration: 3ms Spot size: 6–8mm Fluence: 45–70J/cm^2	Degree of improvement≥5 (total 9): 50.1% of patients (1–7 treatments)
Su et al[15]	Infantile Hemangioma	Pulse duration: 3ms Spot size: 8mm Fluence: 45–50J/cm^2	Completely regressed after 4 treatments
Wu et al[16]	Infantile Hemangioma	Pulse duration: 3ms Spot size: 8mm Fluence: 45–55J/cm^2	Thickness of 2–5 mm get optimal results
Jiang et al[17]	Infantile Hemangioma	–	Thickness of 2–5 mm get optimal results
Baumgartner et al[18]	Angiokeratoma Circumscriptum	Pulse duration: 3ms Spot size: 10mm Fluence: 30J/cm^2	Significant reduction of hypertrophic nodular lesion after 3 treatments
Lorgeou et al[19]	Angiokeratoma Circumscriptum	Pulse duration: 20ms Spot size: 3mm Fluence: 320J/cm^2	A reduction of 90% after 3 treatments
Ross et al[20]	Telangiectasia	Pulse duration: 3–80ms Spot size: 6mm Mean fluence: 88J/cm^2	A reduction of 48% after 1 treatment
Ross et al[21]	Telangiectasia	Pulse duration: 60ms Spot size: 6mm Mean fluence: 89J/cm^2	Clearance approached 65% after 1 treatment

(*Continued*)

Table 1 (Continued).

Author	Aim	Parameters	Outcomes
Nguyen et al[22]	Telangiectasia	Pulse duration: 12–20ms Spot size: 5mm Fluence: 55–140J/cm^2	Clearance approached 71.69% after 1 treatment
Li et al[23]	Port Wine Stain	Pulse duration: 8ms Spot size: 3mm Fluence: 35–50J/cm^2	Work best with hypertrophic, purple lesions
Li et al[24]	Port Wine Stain	Pulse duration: 3–20ms Spot size: 6mm Fluence: 35–105J/cm^2	Work best with hypertrophied and PDL-resistant vessels

Infantile Hemangioma (IH)

Su et al[14] conducted the initial investigation on the effectiveness of long-pulse alexandrite laser in the treatment of IH in 2014. The retrospective study included 48 children with IH, and the results suggested that early use of a long-pulse alexandrite laser can treat thick/deep IH with a certain degree of efficacy and safety. A case report of the team's use of a long-pulse alexandrite laser for the effective treatment of a thick IH in the labial area was published five years later. In this case, the IH completely regressed and did not relapse 10 months after the fourth treatment. No side effects were discovered other than blistering, which appeared right after the treatment and disappeared within a few days.[15]

The long-pulse alexandrite laser can also be used in combination with other means of treating IH, such as 0.5% timolol maleate eye drops or the 595nm pulsed dye laser. These two retrospective studies found that the long-pulse alexandrite laser not only significantly reduced the sequelae of IH, but also kept the side effects at a low level. It also had the best results for thick IH with a thickness of 2–5 mm.[16,17] Currently, the more popular and efficient option for laser therapy of superficial IH is the pulsed dye laser (PDL).[25] However, thanks to the deeper penetration depth and greater fluence, the long-pulse alexandrite laser is more effective in treating hypertrophic IH, while paired with a skin cooling system to further minimize side effects.

The combination of long-pulse alexandrite laser is anticipated to be recognized as one of the first-line alternatives for non-invasive treatment of thick IH in light of these findings. We are currently conducting a study combining a long-pulse alexandrite laser with a traditional Chinese medicine Aspongopus chinensis Dallas for the treatment of IH, and the clinical observation has achieved significant efficacy. After four treatments, a child with mixed IH on her chest had about an 80% reduction in tumor color and volume. Therefore, we believe that the treatment of IH with combined Chinese and Western medicine may become a new direction for future research.

Angiokeratoma Circumscriptum (AC)

Angiokeratomas are vascular mucocutaneous lesions. The most uncommon varieties of angiokeratoma are those classified as AC. In 2016, Baumgartner et al[18] published the first case of the use of a long-pulse alexandrite laser in conjunction with a PDL to treat an AC patient with Fitzpatrick skin type I. The long-pulse alexandrite laser used in this study had treatment parameters of pulse duration of 3 ms, fluence of 30 J/cm^2, and spot size of 10 mm, and it significantly reduced the growth of hypertrophic nodular lesions that were resistant to PDL. The lesion was greatly decreased after 9 sessions. The following year, Lorgeou et al[19] attempted to apply a long-pulse alexandrite laser alone to the treatment of a patient with Fitzpatrick skin type II (pulse duration: 20 ms, fluence: 320 J/cm^2, spot size: 3 mm). After 3 treatments, the lesions were reduced by 90%.

In these two case reports, the long-pulse alexandrite laser is shown to be remarkably effective in the treatment of AC, and it is speculated that this may be due to the strong absorption of laser energy by deoxyhemoglobin at the lesion site. Furthermore, both when combined and when used alone, the adverse effects were moderate, however, patients with Fitzpatrick skin type II displayed mild scarring following laser treatment, which we speculate may be related to the increased fluence of the laser applied and the patients' darker skin tones.

Telangiectasia

It is debatable if long-pulse alexandrite lasers are effective for treating telangiectasias, and this may depend on the kind of vessel and the diameter of the vessel.

The long-pulse alexandrite laser was used to treat 34 individuals with telangiectasias on the face and legs who had light skin types (Fitzpatrick skin types I–III). The ideal set of parameters for the treatment of telangiectasias on the legs and face were found to be 60 ms, 89 J/cm^2, and 6 mm, respectively, by adjusting the pulse duration, fluence, and spot size in a stepwise manner with the dynamic cooling device (DCD) set at 50 ms spray and 20 ms delay. Twelve weeks after a single treatment under these conditions, leg vessels were reduced by 65%. However, even when the optimal parameters were applied, the long-pulse alexandrite laser was still ineffective in occluding fine red vessels smaller than 0.6 mm. This may be due to the low content of oxyhemoglobin in small red vessels and the low absorption of oxyhemoglobin by the long-pulse alexandrite laser, which results in epidermal damage prior to vessel damage. In contrast, the long-pulse alexandrite laser is more effective on larger blue vessels greater than 0.6 mm, but patients with dark skin types are more likely to experience side effects such as hyperpigmentation.[20,21] Another prospective study compared the effectiveness of therapy with a long-pulse Nd:YAG laser and a long-pulse alexandrite laser for leg veins in patients with dark skin types (Fitzpatrick skin type IV). At 4 weeks following a single treatment, the data showed a 71.87% and 71.69% reduction in vessels in both groups, which was not a statistically significant difference. However, compared to the long-pulse Nd:YAG laser, the incidence of postoperative hyperpigmentation was roughly 13% lower with the long-pulse alexandrite laser. In conclusion, both lasers were much more effective in treating larger vessels than smaller ones, and the long-pulse alexandrite laser therapy group's postoperative erythema and pain symptoms were noticeably less severe.[22]

Port Wine Stain (PWS)

PWS is a congenital benign intradermal vascular malformation that manifests as a pink lesion at birth then gradually deepens to a bright red or purple red color with age and thickens into a plaque or nodule. PDL is the most common treatment,[26] and long-pulse alexandrite laser shows unique treatment advantages in hypertrophic PWS. A study comparing a long-pulse alexandrite laser and a PDL in 11 PWS patients (Fitzpatrick skin types III, IV) revealed that the long-pulse alexandrite laser was superior to the PDL in treating hypertrophic PWS. The authors speculated that this might be connected to the fact that deoxyhemoglobin, which is preferentially targeted by the long-pulse alexandrite laser, is present in high concentrations in hypertrophic PWS. In addition to this, the higher fluence of the long-pulse alexandrite laser may contribute to the improved efficacy due to the higher fluence required to reach the therapeutic endpoint.[23] Li et al[24] observed and compared the therapeutic efficacy of long-pulse alexandrite laser, PDL and Nd:YAG laser by using 42 vessels conforming to the typical vessel diameters of PWS on the dorsal side of male SD rats as a target vessel model. The results showed that the long-pulse alexandrite laser had the best therapeutic effect on hypertrophied and PDL-resistant vessels in low and moderate-melanin-concentration skin.

However, the therapeutic endpoint of the long-pulse alexandrite laser in the treatment of PWS is also worth discussing. Li et al's subsequent studies revealed that the long-pulse alexandrite laser's vascular thermal effect was primarily localized contraction, which was halfway between PDLs' instant bleeding and Nd:YAG lasers' full contraction. The investigators postulated that this might be closely related to the inhomogeneous heating of the vascular lumen by the long-pulse alexandrite laser, a mechanism that might cause a decrease in the local blood supply of the vessels as well as microvascular hemorrhage after the laser procedure. This also explains why the immediate emergence of a gray hue with the progressive shift to persistent dark purpura is the endpoint of long-pulse alexandrite laser treatment in PWS.[27]

Long-Pulse Alexandrite Laser in Pigmented Lesions

Currently, research on long-pulse alexandrite lasers focuses on their effectiveness in the treatment of superficial pigmented lesions (Table 2).

Lentigo and Freckle

Lentigines and freckles are typical superficial pigmented lesions. Results of a prospective study based on 18 patients with light skin types (Fitzpatrick skin type II) showed that the long-pulse alexandrite laser effectively cleared lentigines in a

Table 2 Application of Long-Pulse Alexandrite Laser in Pigmented Lesions

Author	Aim	Parameters	Outcomes
Trafeli et al[28]	Lentigo and Freckle	Pulse duration: 3–60ms Spot size: 10mm Fluence: 9–88J/cm^2	Optimal overall lesion clearance up to 76%-99% after 1 treatment
Ho et al[29]	Lentigo and Freckle	Pulse duration: 100μs Spot size: 4mm Fluence: 11–13J/cm^2	Majority of patients reported moderate to marked improvement after 1 treatment
Ho et al[30]	Lentigo and Freckle	Pulse duration: 3ms Spot size: 10mm Fluence: 25–30J/cm^2	No significant improvement and 20% of PIH risk
Lee et al[31]	Melasma	Pulse duration: 3ms Spot size: 8–12mm Fluence: 20–26J/cm^2	>50% of improvement: 44% of patients (single treatment)
Lee et al[32]	Melasma	Pulse duration: 0.5–1ms Spot size: 15mm Fluence: 60–80J/cm^2	A 30.5% reduction in the mMASI score (2–4 treatments)
Kim et al[33]	Seborrheic Keratosis	Pulse duration: 3ms Spot size: 6mm Fluence: 35J/cm^2	A mean improvement score of 3.4 after a mean 1.1± 0.4 treatments
Choi et al[34]	Becker's Nevus	Pulse duration: 3ms Spot size: 15–18mm Fluence: 20–25J/cm^2	>50% of clearance: 63.6% of patients (mean 3.9 treatments)
Choi et al[35]	Becker's Nevus	Pulse duration: 0.5–5ms Spot size: 5–20mm Fluence: 10–24J/cm^2	>50% of clearance:75% of patients (2.0±1.0 treatments)

single treatment, with optimal efficacy for darker lesions and lighter skin tones, and overall lesion clearance of 76%-99%, with no significant side effects detected. The study concluded that long-pulse alexandrite laser may be able to remove lesions efficiently over large areas while protecting normal skin from damage by virtue of gentler heating. However, the study did not use DCD in combination with the treatment, and the researchers noted that DCD may overcool the central area and undercool the surrounding areas and that the slight stinging it induces by itself may reduce the comfort of the treatment.[28]

In addition to DCD, other factors such as pulse width, and spot size also have an impact on how well the long-pulse alexandrite laser treats disease. Ho et al[29] compared the effectiveness of the QS alexandrite laser with that of the long-pulse alexandrite laser in the treatment of freckles and lentigines in patients with darker skin types (Fitzpatrick skin types III, IV). They discovered that the long-pulse alexandrite laser with microsecond pulse widths still achieved satisfactory results, with lower levels of intraoperative pain and postoperative side effects, and more effective treatments. The incidence of hyperpigmentation in patients was 16% lower than with the QS alexandrite laser, which may be related to the absence of photomechanical effects with the long-pulse alexandrite laser and the smaller spot size (4 mm). In another comparative study, the long-pulse alexandrite laser was used with a larger spot size (10 mm) and fluence. Compared to the PDL, 532nm QS Nd:YAG laser, and 532nm long-pulse potassium titanyl phosphate (KTP) laser, the long-pulse alexandrite laser did not show a significant therapeutic effect and had the highest risk of hyperpigmentation.[30]

Melasma

Korean scholars LEE et al[31] first introduced the long-pulse alexandrite laser as a form of photorejuvenation for the treatment of photoaging facial hyperpigmentation lesions. 62 patients with Fitzpatrick skin types III and IV were treated with a single session of the long-pulse alexandrite laser, and 44% of them, including those with Melasma, believed that their facial hyperpigmentation had improved significantly (pulse duration 3ms, fluence 20–26J/cm^2, spot size 8–12mm). Another retrospective study of 48 melasma patients found that long-pulse alexandrite laser treatment significantly reduced the mean melasma area and severity index (mMASI) scores in those with epidermal, mixed melasma, with a decrease of 30.5% 2 months after the last treatment. This study's laser treatment parameters were pulse duration of 0.5–1 ms, fluence of 60–80 J/cm^2, and spot size of 15 mm. A fractional laser handpiece was used, which not only had fewer side effects but also lightened the skin tone overall. However, the study also pointed out that the long-pulse alexandrite laser was not effective on dermal melasma. This might be because the fractional handpiece limits the laser's depth of penetration while the long pulse duration encourages collagen regeneration and restructuring.[32]

Seborrheic Keratosis (SK)

Kim et al[33] suggested that long-pulse alexandrite laser combined with DCD could be effective in treating SK of various shapes and colors in Asian patients. For example, a long-pulse alexandrite laser can treat SK with lighter-colored lesions by destroying large cellular nests. Postoperative crusting, erythema, and hypopigmentation are possible side effects. This prospective study, which included 13 patients with Fitzpatrick skin types III and IV, concluded that in epidermal lesions in Asian patients, the use of DCD may improve efficacy and reduce side effects. TRAFELI et al[28] countered that the use of DCD could result in underexposure of the target area to laser light and overexposure of the normal skin around it to high temperatures, which would not improve efficacy. We hypothesize that this discrepancy in opinion may be due to the different skin colors of the patients included in the two studies.

Becker's Nevus (BN)

BN is a skin pigmentation with hirsutism. Given the remarkable therapeutic effects of long-pulse alexandrite laser on hyperpigmentation and hirsutism, respectively, Choi et al[34] attempted to apply long-pulse alexandrite laser to the treatment and study of BN. The results of the study, which involved 11 patients with BN (Fitzpatrick skin types III, IV), revealed that 63.6% of the patients had more than 50% pigment removal after an average of 3.9 treatments with the long-pulse alexandrite laser. Mild hypopigmentation and alterations in skin texture were side effects, and post-procedure crusting subsided after one week. Notably, DCD was not applied in this study. Another retrospective study with 13 BN patients (Fitzpatrick skin types III and IV) showed that the rates of hair removal and pigment removal of 50% or more at the lesion site were 86.7% and 69.2%, respectively, after an average of 2.3 treatments with the long-pulse alexandrite laser. This study showed relatively few side effects, with no crusting, significant edema, or temporary hyperpigmentation seen throughout.[35] Both studies demonstrated the effectiveness and safety of long-pulse alexandrite laser treatment for BN. The results of the second study seem to be more supportive of the advantages of the long-pulse alexandrite laser for the treatment of BN by comparing the efficacy of the treatment and the side effects when the parameters of the laser treatments are similar, which may be related to the use of the DCD.

Conclusion

The long-pulse alexandrite laser has shown good results in the treatment of hair removal, vascular lesions, and pigmented lesions. Not only that, the long-pulse alexandrite laser has also shown potential in the treatment of venous lakes of lips, recalcitrant viral warts, and basal cell nevus syndrome, but systematic studies with larger sample sizes or comparisons with different lasers are still lacking.[36–38] This article summarizes the following key aspects that should be considered in the application of long-pulse alexandrite laser treatment. First, reasonable treatment parameters should be selected according to the patient's skin color, lesion depth, and the content of target chromophores in the lesion. Second, the use of skin cooling systems such as DCD is important for treatment protocols for patients with high laser fluence or dark skin. Finally, combination therapy may improve the therapeutic efficacy of long-pulse alexandrite laser. In the future, we will further advocate the combination of long-pulse alexandrite laser with a variety of treatments, such as the combination of various lasers, medicines or mesotherapy, etc., to realize comprehensive cosmetic and therapeutic effects.

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Disclosure

The authors declare that there are no conflicts of interest in this study.

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