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ORIGINAL ARTICLE

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Refractory solar lentigines successfully treated with 532-nm nanosecond Nd:YAG Vasculature Salvage Laser Surgery (VSLS) system: Case series

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Abstract

Background: Solar lentigo, a common epidermal hyperpigmented lesion found in sun-exposed areas, results from the proliferation of melanocytes and the accumulation of melanin. Although various treatments for solar lentigo have been explored, they often lead to complications, including prolonged erythema and post-inflammatory hyperpigmentation (PIH), posing significant concerns.

Objectives and methods: This study evaluated the safety and efficacy of the Vasculature Salvage Laser Surgery (VSLS) system. We treated six Korean patients, each with solar lentigo, in a single session using the 532-nm nanosecond neodymium-doped yttrium aluminum garnet (Nd:YAG) VSLS system, with follow-up periods ranging from 3 to 10 weeks.

Results: The treatment led to the complete removal of pigmented lesions in all patients without resulting in PIH, even in cases where previous laser treatments had failed. The only side effect observed was mild erythema, which resolved over the long term in most instances.

Conclusions: The VSLS system emerges as a safe and effective treatment for pigmented lesions, including refractory solar lentigines. Nonetheless, additional studies are required to verify its long-term efficacy.

KEYWORDS
Nd:YAG laser, pigmented lesions, postinflammatory hyperpigmentation, solar lentigo, VSLS system

1 | INTRODUCTION

Solar lentigo, a relatively common epidermal hyperpigmented lesion, manifests in sun-exposed areas as a result of melanocyte proliferation and melanin deposition.[1] While these lesions are benign, their potential to cosmetically disfigure and diminish quality of life necessitates treatment.[2] Various treatments have been explored, including topical tretinoin, cryotherapy, lightening peels, and, more recently, laser surgery.[2] The Q-switched (QS) 532-nm neodymium-doped yttrium aluminum garnet (Nd:YAG) laser is the most frequently employed laser.[3] Its capability to emit short bursts of high energy allows for the destruction of melanosomes and melanin-containing cells through photothermal and photomechanical effects.[3] Despite the efficacy and safety of QS lasers in removing solar lentigines, the associated high risk

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FIGURE 1 A 70-year-old woman received one 532-nm nanosecond Nd:YAG VSLS system (A), before treatment and (B), 4 weeks after the treatment and (C), 8 weeks after the treatment). Nd:YAG, neodymium-doped yttrium aluminum garnet; VSLS, vasculature salvage laser surgery.

of complications, such as prolonged erythema and postinflammatory hyperpigmentation (PIH), fosters patient hesitancy toward QS laser treatments.[3]

In response to these challenges, the vasculature salvage laser surgery (VSLS) system introduces two innovative technologies distinct from the traditional QS Nd:YAG laser.[4] The first innovation involves a contact cooling system (ranging from −10°C to 0°C) designed to minimize thermal damage to the adjacent epidermis. This cooling mechanism significantly reduces cutaneous inflammation, thereby lowering the risk of PIH. The second advancement is automatic laser treatment technology, which selectively targets and uniformly irradiates only the pigmented lesions.[4] This paper discusses the successful treatment of six patients with refractory solar lentigines using the 532-nm nanosecond Nd:YAG VSLS system.

2 | CASE 1

A 70-year-old woman presented to our clinic with light brown patches on her left cheek (Figure 1A). She had previously undergone treatments including intense pulsed light (IPL), laser toning, and multiple sessions with a 532-nm Nd:YAG laser, all of which failed to produce the desired results. Diagnosed with refractory solar lentigines, we applied a VSLS system using a classic 532-nm QS Nd:YAG laser (Reepot, Ilooda, Suwon, Republic of Korea) at settings of 220 mj, 1.75 J/cm^2. Four weeks posttreatment, the pigmentation had vanished and mild erythema was noted (Figure 1B), which subsequently resolved within the following 4 weeks (Figure 1C).

3 | CASE 2

A 67-year-old woman presented with irregularly shaped, light brown patches on her left cheek (Figure 2A), reporting that the lesions darkened following treatments with a CO_2 laser and a 532-nm Nd:YAG laser. Upon diagnosing refractory solar lentigines, we administered treatment using the VSLS system with parameters identical to those in Case 1. Four weeks after the treatment, significant improvement was observed, with only minimal erythema remaining (Figure 2B).

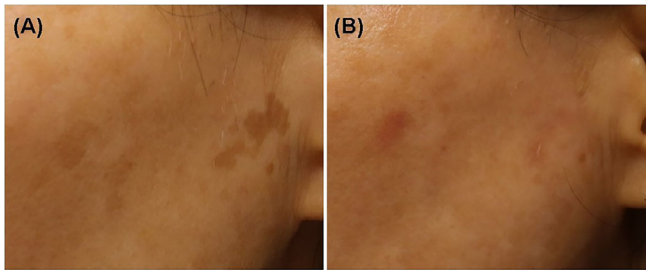


FIGURE 2 Solar lentigines located on the pre-auricular area of a 67-year-old woman, before (A) and at 4 weeks after the laser treatment (B).

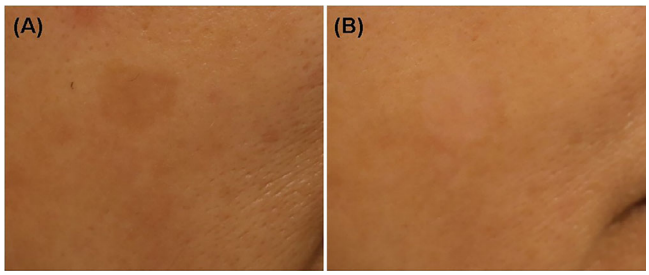


FIGURE 3 A solar lentigo located on the right cheek of a 65-year-old woman, before (A) and at 10 weeks after the laser treatment (B).

4 | CASE 3

A 65-year-old woman had a light brown patch on her right cheek (Figure 3A), which persisted after treatments with a 532-nm QS Nd:YAG laser and a picosecond 755-nm Nd:YAG laser at our outpatient clinic. Diagnosed with refractory solar lentigines, we treated the lesion using the VSLS system, employing the same parameters as in Case 1. Ten weeks following the initial treatment, the lesion had completely cleared (Figure 3B).

5 | CASE 4

A 56-year-old male presented with a brown patch on the left lateral orbital area (Figure 4A). He reported that the lesion became darker

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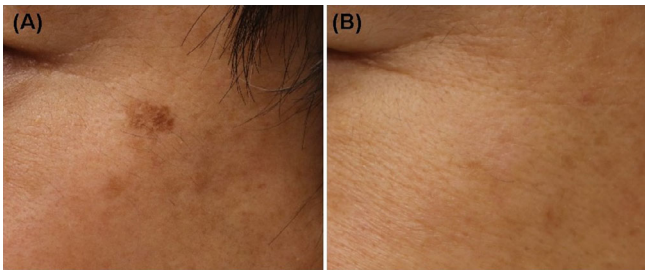


FIGURE 4 A solar lentigo located on the left lateral orbital area of a 56-year-old man, before (A) and at 4 weeks after the laser treatment (B).

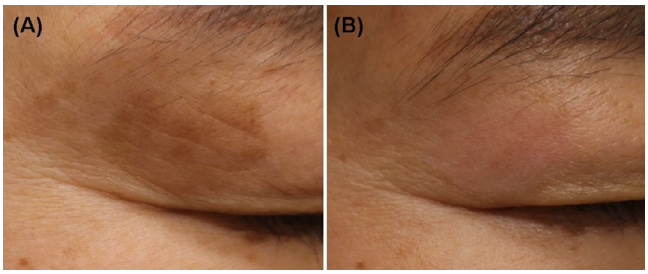


FIGURE 5 A solar lentigo located on the right upper eyelid of a 41-year-old man, before (A) and at 3 weeks after the laser treatment (B).

after treatments with CO_2 laser, 532-nm QS Nd:YAG, and 785-nm picosecond Nd:YAG laser. The diagnosis was refractory solar lentigines, and treatment with a VSLS system was administered, using a parameter of 220 mj, 1.75 J/cm^2. Four weeks after the initial treatment, the lesion had completely cleared (Figure 4B).

6 | CASE 5

A 41-year-old female sought cosmetic removal of a large, light brown patch on the right upper eyelid (Figure 5A). This lesion remained after two treatments with a 532-nm QS Nd:YAG laser. To address the refractory solar lentigines, laser treatment using the VSLS system with the same parameters as in Case 1 was applied. Three weeks after the initial treatment, the pigmentation had completely cleared, leaving only slight erythema (Figure 5B).

7 | CASE 6

A 47-year-old female was concerned about speckled, light brown patches on her left cheek (Figure 6A). This was the remaining lesion after two treatments with a 532-nm Nd:YAG laser. A diagnosis of refractory solar lentigines was made, and treatment with the VSLS system was performed, using the same parameters as in Case 1. Four weeks after the first treatment, the pigmentation had completely cleared (Figure 6B).

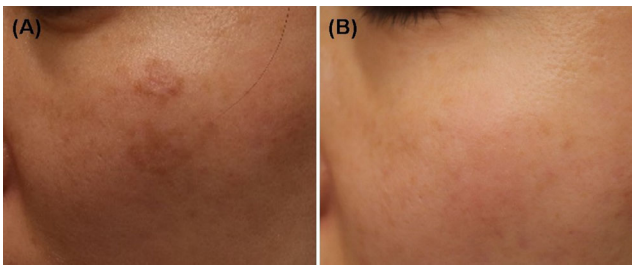


FIGURE 6 Solar lentigines located on the left cheek of a 47-year-old woman, before (A) and at 4 weeks after the laser treatment (B).

8 | DISCUSSION

All six patients achieved complete removal of pigmented lesions, previously unresponsive to other laser treatments, after just a single session with the VSLS system. The only notable side effect was mild erythema, which largely resolved upon follow-up.

Although some beneficial effects of other laser wavelengths for lentigines such as 1064 nm, 755, and 675 nm were reported, the 532-nm QS Nd:YAG laser is frequently employed for solar lentigines treatment owing to its efficacy.[5–10] While 1064 nm, 755 nm, and 675 nm lasers offer the advantage of deeper dermal penetration, contributing to skin rejuvenation, the 532 nm laser provides a more targeted and effective treatment for lentigines by specifically addressing epidermal pigmentation. However, the substantial risk of complications, including prolonged erythema and PIH, causes concern and deters patients from opting for QS laser therapies. PIH and hypopigmentation often result from cutaneous inflammation, which affects the surrounding vessels by producing inflammation through a photomechanical effect.[3] The severity of PIH correlates with the inflammation degree and the disruption extent at the dermo-epidermal junction. Laser treatment destruction of the basal cell layer in inflamed skin releases a significant amount of melanin from keratinocytes, which macrophages phagocytose in the upper dermis, leading to dermal melanosis.[3] Additionally, sun reexposure and hormonal changes can cause the recurrence of lentigines.[11] Darker-skinned individuals are more prone to PIH, with an incidence rate of approximately 25% in Asians following QS Nd: YAG laser treatment.[3] Both nanosecond and picosecond lasers are effective in treating lentigines, with picosecond lasers offering potentially faster and more precise pigment disruption due to their shorter pulse duration. However, the higher energy levels of picosecond lasers may increase the risk of side effects such as erythema and post-inflammatory hyperpigmentation.[12]

The VSLS system employed in these cases features a contact cooling system and automatic laser treatment technology. The incorporation of epidermal cooling using Cryogenic Precision Temperature Control (CPTL) technology during laser procedures reduces pain associated with the treatment, enables safer applications in individuals with darker skin tones, and allows for the utilization of relatively high fluences with precision to preserve treatment.[13] Precision-controlled hyper cooling at a constant temperature facilitates the delivery of high-powered energy to the target area by triggering artificial vas-

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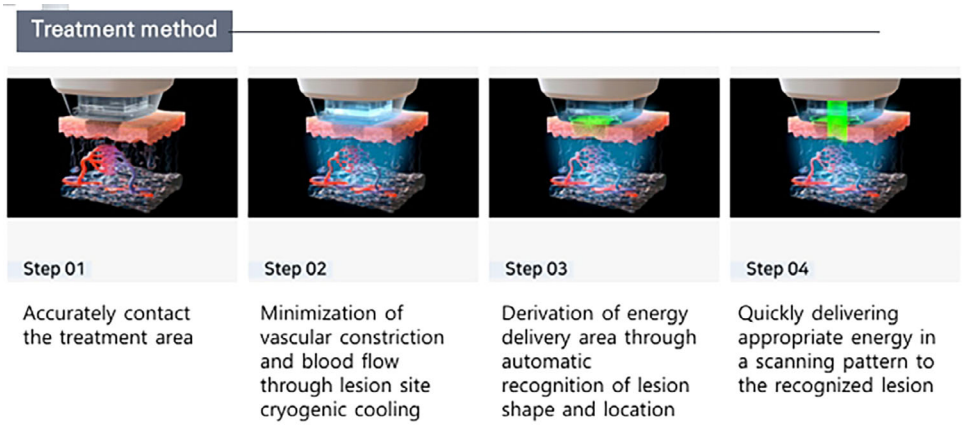


FIGURE 7 The treatment method of the VSLS system. VSLS, vasculature salvage laser surgery.

cular contractions. Supercooling control system actively controls chromophores (hemoglobin) which could cause side effects or reduce the effectiveness, by temporarily blocking the flow of blood within the capillaries located in the papillary dermis. Relatively increased amount of energy absorbed by melanin allows for high-energy delivery focused on pigmented lesions contributing to safer and more effective treatment during laser therapy.[14] Preventing its temperature from surpassing the threshold for thermal damage also minimizes the risk of nonspecific thermal injury to the skin surface caused by laser pulses, which in turn may reduce the incidence of PIH.[13] The system's automatic laser treatment technology focus the laser energy exclusively on the target, ensuring uniform irradiation. Autoderm (lesion recognition algorithm) technology allows for targeting specific disease areas designated by the user, and effectively delivers multiple rapid shots, thereby avoiding any skin damage caused by prolonged exposure to the cold. Real time recognition of lesion shape and location enables the extraction of appropriate scanning areas and displays the range of energy delivery on the handpiece, considering the laser beam characteristics, thereby minimizing untreated areas (Figure 7).

In conclusion, the 532-nm nanosecond Nd:YAG VSLS system is a safe and effective method for treating pigmented lesions, including refractory solar lentigines that did not respond to previous treatments. Further research is necessary to verify its long-term efficacy and to establish appropriate parameters for treating various pigmentation conditions.

AUTHOR CONTRIBUTION

So Young Lee and Ka Ram Kim: Original draft, investigation. Seunghyeon Kim: conceptualization, data curation. Hye Sung Han: Validation, investigation. Ji Yeon Hong: formal analysis, project administration. Joon Seok: review and edit the manuscript. Kui Young Park: Conceptualization, methodology, review, and editing manuscript.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

INFORMED CONSENT

The patients in this manuscript provided written informed consent for the publication of their case details and clinical pictures.

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REFERENCES

1. Scarcella G, Dethlefsen MW, Nielsen MCE. Treatment of solar lentigines using a combination of picosecond laser and biophotonic treatment. *Clin Case Rep*. 2018;6(9):1868-1870.
2. Todd MM, Rallis TM, Gerwels JW, Hata TR. A comparison of 3 lasers and liquid nitrogen in the treatment of solar lentigines: a randomized, controlled, comparative trial. *Arch Dermatol*. 2000;136(7):841-846.
3. Kang HJ, Na JI, Lee JH, Roh MR, Ko JY, Chang SE. Postinflammatory hyperpigmentation associated with treatment of solar lentigines using a Q-Switched 532-nm Nd: YAG laser: a multicenter survey. *J Dermatolog Treat*. 2017;28(5):447-451.
4. Kim YH, Cheon YS, Jeong GH, et al. The efficacy and stability of 532 nm nanosecond Nd: YAG Vasculature Salvage Laser Surgery (VSLS) system in ex vivo pigmented micropig skin. *Lasers Med Sci*. 2023;38(1):180.
5. Chan MWM, Shek SY, Yeung CK, Chan HH. A prospective study in the treatment of lentigines in Asian skin using 532 nm picosecond Nd: YAG laser. *Lasers Surg Med*. 2019;51(9):767-773.

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6. Bohnert K, Dorizas A, Sadick N. A prospective, randomized, double-blinded, split-face pilot study comparing Q-switched 1064-nm Nd:YAG versus 532-nm Nd:YAG laser for the treatment of solar lentigines. *J Cosmet Laser Ther*. 2018;20(7-8):395-397.
7. Yang X, Bi C, E T, Lin L, Cao Y. A retrospective study of 1064-nm Q-switched Nd:YAG laser therapy for acquired bilateral nevus of Ota-like macules. *Skin Res Technol*. 2023;29(3):e13298.
8. Agud-Dios M, Perandones-Gonzalez H, Fernández-Domper L, Dominguez Santas M, Boixeda de Miquel P. Picosecond 755-nm alexandrite laser treatment for oral lentiginosis in Peutz-Jeghers disease. *Lasers Surg Med*. 2022;54(6):823-824.
9. Alter I, Fusco I, Madeddu F, Zingoni T. Clinical application of 675 nm laser therapy for dorsal hand skin hyperpigmentation. *Skin Res Technol*. 2023;29(10):e13484.
10. Corecciati L, Gabellone M, Donne PD, Pennati BM, Zingoni T. The 675-nm wavelength for treating facial melasma. *Skin Res Technol*. 2023;29(8):e13434.
11. Ho SG, Chan NP, Yeung CK, Shek SY, Kono T, Chan HH. A retrospective analysis of the management of freckles and lentigines using four different pigment lasers on Asian skin. *J Cosmet Laser Ther*. 2012;14(2):74-80.
12. Chan MWM, Shek SY, Yeung CK, Chan HH. A Prospective Study in the treatment of Lentigines in Asian Skin using 532 nm picosecond Nd:YAG Laser. *Lasers Surg Med*. 2019;51(9):767-773.
13. Manuskiatti W, Eimpunth S, Wanitphakdeedecha R. Effect of cold air cooling on the incidence of postinflammatory hyperpigmentation after Q-switched Nd: YAG laser treatment of acquired bilateral nevus of Ota–like macules. *Arch Dermatol*. 2007;143(9):1139-1S143.
14. Khalkhal E, Razzaghi M, Rostami-Nejad M, Rezaei-Tavirani M, Heidari Beigvand H, Rezaei Tavirani M. Evaluation of laser effects on the human body after laser therapy. *J Lasers Med Sci*. 2020;11(1):91-97.

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