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## Potential efficacy of fractional CO<sub>2</sub> laser in treating port wine stain birthmarks with hypertrophy

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Dear Editor,

Port wine stain birthmarks are congenital vascular diseases caused by excessive capillary dilation, leading to red or purple skin discoloration. As patients age, the lesions often thicken, with 65% developing hypertrophy. Dilated vessels typically range from 10-150  $\mu$ m in diameter and are located 0.6 mm under the skin, but in hypertrophy, they can reach up to 500  $\mu$ m and extend to 3.7 mm deep.<sup>1</sup> Current treatments, including various lasers and photodynamic therapy, target hemoglobin based on the theory of selective photothermolysis. However, these treatments often fall short, especially in patients with hypertrophy. For example, Pulsed Dye Lasers (PDL), the gold standard, may not fully photocoagulate vessels outside the 20-150  $\mu$ m range, dense blood vessel areas, or vessels located deeper than 0.65mm. Potassium Titanyl Phosphate (KTP) lasers and photodynamic therapy may work better on smaller vessels but are limited by epidermal thickness and melanin. Neodymium: yttrium-aluminum-garnet (Nd: YAG) lasers can occlude deeper vessels more effectively than PDL but carry a higher risk of scarring.

A potential solution is the CO<sub>2</sub> laser, which targets water in tissues rather than hemoglobin, making it useful for treating hypertrophic port wine stains. Previous studies suggest that single strikes of fractional lasers cause thermal damage, leading to vessel coagulation and a reduction in vessel numbers.<sup>2</sup> Fractional CO<sub>2</sub> lasers emit beams that create "micro thermal zones," ablating tissues, including blood vessels, collagen, and melanocytes. This allows them to vaporize blood vessels of any size, density, or arrangement. The micro thermal zones can exceed the diameter of large vessels resistant to PDL (over 150  $\mu$ m) and reach depths of up to 4 mm, far deeper than PDL. Therefore, factors limiting hemoglobin-targeting lasers do not affect the efficacy of fractional CO<sub>2</sub> lasers.

For thicker skin or skin with high melanin content, lasers targeting hemoglobin require higher energy pulses to ensure treatment efficacy, which can cause thermal damage to the epidermis. While cooling may be needed to reduce pain when using fractional CO<sub>2</sub> lasers, it doesn't impact treatment efficacy because CO<sub>2</sub> lasers target water in the tissue, not hemoglobin. Therefore, the thickness and melanin content of the epidermis do not limit the effectiveness of fractional CO<sub>2</sub> lasers.

Angiogenesis and recanalization often accompany tissue healing. In laser treatments for port wine stains (*e.g.*, PDL, argon laser, continuous CO<sub>2</sub> laser, KTP laser, Nd-YAG laser, photodynamic therapy), the number and diameter of dilated blood vessels in the lesion areas decrease, while new normal capillaries and smaller dilated vessels increase. Fractional CO<sub>2</sub> laser has shown similar benefits in treating burn scars by reducing vessel diameter, decreasing blood flow, and reducing erythema. If fractional CO<sub>2</sub> laser can reduce vessel diameter to below 150  $\mu$ m, within the effective range of PDL, it could make previously resistant lesions more responsive to PDL treatment later.

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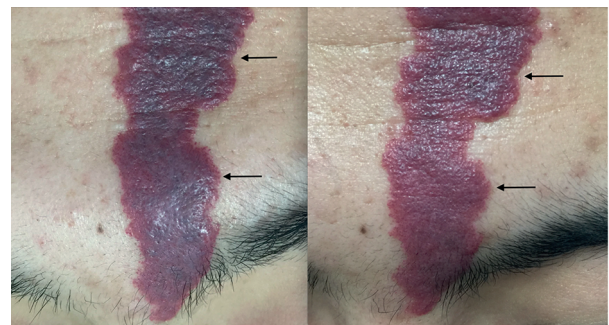
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Unlike PDL, which only photocoagulates large dilated blood vessels, fractional CO<sub>2</sub> laser ablates normal-diameter capillaries, lymphatic vessels, collagen fibers, and melanocytes within its path. However, the micro thermal zones it creates typically cover only 15-25% of the lesion area, allowing intact tissue between zones to facilitate a shorter healing process compared to other lasers. Due to this low coverage, fractional CO<sub>2</sub> laser requires multiple sessions to fully treat the lesion, similar to PDL. However, unlike PDL, which can cause cobblestone-like changes after multiple treatments, fractional CO<sub>2</sub> laser has a very low risk of scarring or other side effects, making it a popular choice for facial rejuvenation and scar repair. Studies have shown that monthly treatments with fractional CO<sub>2</sub> laser are both effective and safe.<sup>3</sup>

Our previous work described two cases with hypertrophic port wine stain birthmarks treated with fractional CO<sub>2</sub> lasers for 5 years.<sup>4</sup> When compared to PDL, no topical anesthesia was applied in both cases and patients reported better tolerance of pain; only minor bleeding spots were found; and no infection or scarring was reported after the treatment. The color of the lesion areas in both cases changed from purple to light red (Figure 1). The lesion areas that protrude skin surface were lowered and reduced. Using the Vancouver Scar Scale, the score was reduced from 12 to 9. The findings demonstrate that fractional CO<sub>2</sub> laser has the potential to be an effective modality for the treatment of patients with hypertrophic port wine stains.

In conclusion, fractional CO<sub>2</sub> lasers have the potential to be used as an alternative treatment in the state of port wine stain with hypertrophy to other laser treatments.



**Figure 1.** Changes of lesion after treatment. Before the 1<sup>st</sup> treatment vs. before the 5<sup>th</sup> treatment. The lesion is located in the forehead area. The interval between each treatment was one month (from Zhang, 2023).<sup>4</sup>

#### Key words

Fractional CO<sub>2</sub> laser, port wine stain birthmarks.

#### Conflict of interest

The author declares no potential conflict of interest and confirms accuracy.

#### Ethics approval

Not applicable.

#### Informed consent and consent for publication

Not applicable.

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