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ORIGINAL ARTICLE

Histochemical Evaluation of the Vessel Wall Destruction and Selectivity After Treatment with Intense Pulsed Light in Capillary Malformations

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Stacking;
Selective photothermolysis

Abstract
Background: Among the different approaches for improving the effectiveness in the treatment of Capillary Malformations type Port Wine Stain (CM type PWS) are the intense pulsed light sources. There are few clinical studies prove useful in the treatment of CM. Furthermore, no studies have been published yet demonstrating the histological effects of IPL in CM.
Objectives: To assess the histological effects of pulsed light in capillary malformations type port wine stain. We wanted to compare epidermal, dermal and vessel wall damage after treatment with different combinations of IPL parameters.
Material and methods: Fifty-five post-treatment biopsies were performed in 15 consenting patients with CM and stained with nitroblue-tetrazolium chloride (NBTC). Patients had not been treated previously.
Results: Fifteen patients with CM, with a median age of 39 years-old were enrolled in this study. In this series, the patients with the most severe epidermal damage were those with a darker phototype. Pink CM were especially resistant to treatment, even using high fluences, short pulse durations and stacking pulses. Longer intra- and interpulse delays were effective in purple CM, achieving adequate vessel destruction.
Conclusions: IPL devices provide a vast amount of treatment possibilities and further studies are necessary to optimize therapeutic approaches to CM. In this study we have observed the histological effects of different pulses on the MC type PWS.

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PALABRAS CLAVE
Malformaciones capilares;
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Múltiples pulsos;
Cloruro de nitroazul-tetrazolio (NBTC);
Pulsos consecutivos;
Fototermólisis selectiva

Evaluación histoquímica de la destrucción de la pared del vaso y la selectividad después del tratamiento con luz pulsada intensa en las malformaciones capilares

Resumen

Antecedentes: Entre las distintas estrategias para intentar mejorar la eficacia en el tratamiento de las malformaciones capilares tipo mancha en vino de Oporto (MC tipo MVO) están las fuentes de luz pulsada intensa. Existen hasta la fecha pocos estudios clínicos que avalen su utilidad en el tratamiento de las MC. Además, no disponemos de estudios histológicos que objetiven los efectos de la luz pulsada en la coagulación de estos vasos anómalos.

Objetivos: Evaluar los efectos histológicos de la luz pulsada en las MC tipo MVO. Intentamos comparar el daño epidérmico, dérmico y de la pared de los vasos después del tratamiento con distintos parámetros de IPL.

Material y métodos: Fueron realizadas 55 biopsias postratamiento en las MC de 15 pacientes. Las muestras fueron teñidas con cloruro de nitroblue tetrazolium.

Resultados: Quince pacientes (edad media: 39 años) fueron inscritos en este estudio. En esta serie los pacientes con mayor daño epidérmico fueron aquellos con un fototipo más alto (>IV). Las malformaciones de color rosa pálido eran especialmente resistentes al tratamiento, incluso con altas *fluencias*, duraciones de pulso corto y pulsos repetidos. Los pulsos de una mayor duración fueron especialmente eficaces en malformaciones capilares violáceas.

Conclusiones: Los equipos de IPL ofrecen una gran cantidad de opciones de tratamiento en las MC, sin embargo necesitamos conocer mejor sus efectos para realizar abordajes más eficaces y seguros. En este estudio hemos podido observar los efectos histológicos de los distintos pulsos sobre las MC tipo MVO.

Introduction

Capillary malformations type port wine stain (CM type PWS) constitute congenital anomalies that are believed to represent errors in vascular development during embryogenesis.[1–4]

Currently, pulsed dye laser (PDL) remains the *gold standard* treatment for CM.[1,4–6] However, 25–50% of treated lesions do not demonstrate significant improvement.[7] Other options have been used in resistant lesions, such as alexandrite, neodymium-YAG, dual wavelength lasers[8] and, more recently intense pulsed light (IPL) sources.[3]

IPL systems emit non-coherent broadband light with wavelengths in the 515–1200 nm range[6] and, theoretically, this spectrum matches the absorption coefficient and thermal relaxation time of a broader range of vessels within CM.[9] Similar to laser systems (though less selective than them), this technology seems to respect the principle of selective photothermolysis (SP),[3,10] which consists in the preferential absorption of light by oxy/deoxy-hemoglobin and the subsequent conversion into thermal energy, leading to the selective coagulation of blood vessels.[11] Specific output wavelengths depend on the cutoff filters used,[6] which optimize absorption of the target chromophores, reduce the strong absorption of melanin and prevent adverse effects such as erythema, blistering and crusting.[12] Recently, the optimized pulsed light sources (OPL) have been developed, providing a dual-band output spectrum from 500 to 670 nm and 870 to 1200 nm, which are even more selective to oxy/deoxy-hemoglobin. Theoretically, the use of OPL reduces the risk of epidermal damage, by displacing the interval between 610 and 870 nm, characterized by melanin's absorption peak.[13]

IPL systems allow the individual selection of multiple parameters, such as: wavelength, pulse duration, fluence, multipulse mode and intrapulse time delay.[12] On the other hand, we can also use only one pulse or multiple pulses, with different delays, creating a multiplicity of possible combinations.

Although IPL sources have been increasingly used in the treatment of CM, there are very few clinical studies regarding their effectiveness.[5,11] Furthermore, we have not found any published histochemical studies describing the histological effects of IPL treatment of CM. We aim to describe the vascular, epidermal and dermal tissue damage in CM treated with IPL with variations in multiple parameters using nitroblue-tetrazolium chloride (NBTC) histochemical staining of biopsies taken from the CM immediately after treatment.[4,14–17]

Material and methods

Fifteen adult patients with CM were enrolled in this study. Four men and eleven women were treated with the Ellipse Flex (Ellipse®, Denmark) IPL device that can provide two different spectrums of polychromatic light, according to the different cut-off filters used: between 555 and 950 nm (VL-2®) and 530 and 750 nm (PR®). For epidermal protection, a cold-air cooling system (Cryos5™, Zimmer Medizinsysteme GMbH, Neu-Ulm, Germany) and an ultrasound gel were used. Different wavelengths, fluences, pulse durations, inter- and intradelay times with stacking pulses[18,19] and multiple passes were used to treat an average of four CM test areas per patient (range 2–7). The hospital's ethics committee approved the study. Fully informed written consent was obtained from all patients before the first