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Review article

Update on subthreshold micropulse laser treatment for retinal diseases: A narrative review

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ABSTRACT

Subthreshold micropulse laser (SML) has emerged as a valuable and effective alternative to conventional laser treatments for a variety of retinal diseases, offering therapeutic benefits while minimizing tissue damage. Unlike traditional continuous wave lasers which induce irreversible changes to photoreceptors and retinal pigment epithelial (RPE) cells due to thermal damage, SML delivers energy in short bursts with cooling intervals, maintaining subthreshold temperatures that trigger therapeutic cellular responses without causing visible retinal scarring. We have synthesized the latest evidence on SML's role in managing diabetic macular edema (DME), central serous chorioretinopathy (CSCR), macular edema secondary to retinal vein occlusion, and age-related macular degeneration. Across these conditions, SML demonstrates comparable visual and anatomical outcomes to conventional laser and anti-vascular endothelial growth factor therapies, with notable benefits, including a reduced injection burden in DME and improved choriocapillaris perfusion in CSCR. Additionally, emerging data suggests SML may hold an edge in more complex cases, such as chronic CSCR, pseudophakic macular edema, and dome-shaped maculopathy; however, inconsistencies in laser parameters including wavelength, duty cycle, fluence parameters and spot size continue to pose challenges in standardizing treatment protocols. The "reset theory" of RPE restoration, driven by heat shock protein activation or other described mechanisms, underscores SML's potential to offer sustained, long-term disease control. While current evidence is promising, larger, high-quality studies are still needed to fine-tune treatment settings, improve patient selection strategies, and clarify SML's role alongside other therapies. We provide a comprehensive overview of SML's progress, potential, and future direction in retinal disease management.

1. Introduction

Macular diseases are an important cause of visual morbidity and often result in irreversible visual function loss if left untreated. Different treatment approaches have been explored and used in clinical practice, each with its own set of advantages and disadvantages.[1–4] Among them, continuous pulse laser photocoagulation was one of the first to come into use and has evolved through several phases.[5–7] The light energy of the laser is absorbed by a chromophore with variable uptake dependent on the wavelength of the laser, and converted into heat energy, which then exerts its downstream effects. For retinal pigmented epithelial (RPE) cells, this chromophore is melanin.

Conventional laser photocoagulation (LPHC), a continuous wave laser, uninterruptedly delivers this energy. As this energy is continuously absorbed, the resultant thermal energy crosses a "threshold" and causes photocoagulation of the RPE cells and the photoreceptors (PRs)

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