808 nm Wavelength Light Induces a Dose-Dependent Alteration in Microglial Polarization and Resultant Microglial Induced Neurite Growth

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Background and Objective: Despite the success of using photobiomodulation (PBM), also known as low level light therapy, in promoting recovery after central nervous system (CNS) injury, the effect of PBM on microglia, the primary mediators of immune and inflammatory response in the CNS, remains unclear. Microglia exhibit a spectrum of responses to injury,with partial or full polarization into proand anti-inflammatory phenotypes. Pro-inflammatory (M1 or classically activated) microglia contribute to chronic inflammation and neuronal toxicity, while anti-inflammatory (M2 or alternatively activated) microglia play a role in wound healing and tissue repair; microglia can fall anywhere along this spectrum in response to stimulation.
Materials and Methods: The effect of PBM on microglial polarization therefore was investigated using colorimetric assays, immunocytochemistry, proteomic profiling and RT-PCR in vitro after exposure of primary microglia or BV2 microglial cell line to PBM of differing energy densities (0.2, 4, 10, and 30 J/cm2, 808 nm wavelength, 50 mW output power).
Results: PBM has a dose-dependent effect on the spectrum of microglial M1 and M2 polarization. Specifically, PBM with energy densities between 4 and 30 J/cm2 induced expression of M1 markers in microglia. Markers of the M2 phenotype, including CD206 and TIMP1, were observed at lower energy densities of 0.2–10 J/cm2. In addition, co-culture of PBM or control-treated microglia with primary neuronal cultures demonstrated a dosedependent effect of PBM on microglial-induced neuronal growth and neurite extension.
Conclusion: These data suggest that the Arndt–Schulz law as applied to PBM for a specific bioassay does not hold true in cells with a spectrum of responses, and that PBM can alter microglial phenotype across this spectrum in a dose-dependent manner. These data are therefore of important relevance to not only therapies in the CNS but also to understanding of PBM effects and mechanisms.
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