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Exploring the effects of photobiomodulation on the inflammatory process of the adipose tissue of diet-induced obese and hyperglycemic mice

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Introduction: Studies have been reporting obese and hypertrophied white adipose tissue as richly permeated by leukocytes, expressing not only increased TNF-α levels, but also other pro-inflammatory cytokines and chemokines. Inflammatory signaling through activation of Toll-like and TNF receptors (TLRs and TNFRs, respectively) pathways leads to intracellular inhibition of insulin signaling by direct interferences on insulin receptor function and its ability to initiate the insulin signal transduction pathway. If inflammation is a common etiological agent behind all these pathologies, a therapeutic approach that can modulate inflammatory signaling is of noteworthy value. Several studies have been acknowledging photobiomodulation (PBM) as an appealing therapy for inflammatory disorders due to its immunomodulatory properties. Nevertheless, the phototherapeutic approach to manage the chronic inflammatory component of obesity and hyperglycemia has not yet been explored.
Objective: The purpose of this study was to develop a murine model of obesity and hyperglycemia to investigate the effects of PBM on inflammatory infiltrate in adipose tissue of obese and hyperglycemic mice.
Methods: Four week old male adult C57BL/6 mice were submitted to a hypercaloric high-fat diet to induce obesity and hyperglycemia during 8 weeks. After that, animals were treated with PBM during four weeks corresponding to six irradiation sessions using an 843 nm LED (5.7 J cm^{-2} at 19 mW cm^{-2} per session). Animals were irradiated at days 1, 3, 7, 10, 14 and 21 following obesity and hyperglycemia validation. Control animals were submitted to same management but sham-irradiated. All animals received the high-fat diet until the end of experiments. Body mass and blood glucose were assessed regularly during the entire experimental course. Twenty-four-h after the last irradiation, animals were euthanized and subcutaneous samples from abdominal tissue were carefully collected, fixed at formalin 10% and routinely processed for hematoxilin-eosin staining and histological analysis. Standardized areas were selected from each slide and Image J software was used to quantify the areas of inflammatory infiltrate in adipose tissue. Data were submitted to paired sample t-test to attest changes in body mass and blood glucose levels after obesity and hyperglycemia induction. Mann-Whitney test was performed to verify differences between groups regarding inflammatory infiltrate in adipose tissue. Significance was established at $p<0.05$.
Results: Obesity and hyperglycemia were successfully induced after 8 weeks. The body mass and glucose blood significantly increased about 32.2% ($p<0.001$) and 13.7% ($p=0.034$), respectively. Regarding the inflammatory infiltrate in the adipose tissue, non-irradiated control animals displayed areas almost five times higher than the treated group ($p<0.001$). In fact, control group presented 23.3% of area populated with inflammatory cells while for irradiated animal the area corresponded to 4.3%. Considering that the abdominal adipose tissue from treated animals presented diminished areas of inflammatory infiltrates, we assumed that their