OPEN ACCESS Freely available online

ISSN: 2572-5629
Diabetes Case Reports

Perspective

Light-Based Therapy to Reduce Insulin Resistance and Improvement of Glucose Metabolism

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DESCRIPTION

Insulin Photobiomodulation (PBM) is a form of light therapy that uses low-level lasers or Light-Emitting Diodes (LEDs) to stimulate cellular functions and enhance tissue healing. PBM has been shown to have various beneficial effects on different biological systems, such as wound healing, inflammation, pain relief, neuroprotection, and hair growth. Recently, PBM has also been investigated as a potential therapy for improving glucose metabolism and insulin sensitivity in obesity and Type 2 Diabetes Mellitus (T2D). Obesity and T2D are major public health problems that affect millions of people worldwide. They are characterized by chronic hyperglycemia and insulin resistance, which are associated with increased risk of cardiovascular diseases, kidney failure, nerve damage, and other complications. Insulin resistance is a condition where the cells of the body do not respond properly to the hormone insulin, which is responsible for regulating blood glucose levels. Insulin resistance leads to impaired glucose uptake and utilization by the cells, resulting in elevated blood glucose levels and compensatory hyperinsulinemia.

The mechanisms underlying insulin resistance are complex and multifactorial, but they involve oxidative stress, inflammation, mitochondrial dysfunction, endoplasmic reticulum stress, and lipid accumulation in the liver and skeletal muscle. PBM has been proposed as a novel approach to modulate insulin signaling and glucose homeostasis in insulin-resistant tissues. PBM can penetrate the skin and reach the subcutaneous adipose tissue, which is an important endocrine organ that secretes hormones and cytokines that affect glucose metabolism. PBM can also be applied directly to the skeletal muscle, which is the main site of insulin-stimulated glucose uptake. PBM can influence various molecular pathways that are involved in insulin action, such as Akt (Ak Strain Transforming), AS160 (Akt Substrate of 160 kDa), GLUT4 (Glucose Transporter Protein Type-4), AMPK (activated protein kinase), PGC-1α (PPARG coactivator 1 alpha), and SIRT1 (Sirtuin 1). Recently, light-based therapy has also shown a potential treatment for insulin resistance, a condition in which the body's cells do not respond properly to the hormone insulin. By activating these pathways, PBM can enhance glucose transport, oxidation, and storage in the adipose tissue and skeletal muscle, thereby lowering blood glucose levels and improving insulin sensitivity.

Several studies have demonstrated the beneficial effects of PBM on glucose metabolism and insulin resistance in animal models and human subjects. PBM therapy improved glucose tolerance and reversed the high-fat diet-induced reduction of Glucose Transporter Type 4 (GLUT4) content and phosphorylation of Ak Strain Transforming (Akt) and Phosphorylated AS160 (pAS160) in the adipose tissue of obese mice. Photobiomodulation (PBM) therapy combined with exercise training increased insulin sensitivity and reduced fasting blood glucose levels in patients with T2D. PBM therapy reduced glycated Hemoglobin (HbA1c) levels and improved quality of life in patients with T2D. PBM therapy is a promising non-invasive and non-pharmacological intervention for improving glucose metabolism and insulin sensitivity in obesity and T2D. However, light-based therapy is not without limitations and challenges. The optimal parameters of light-based therapy, such as wavelength, intensity, duration, frequency, timing, and site of exposure, are not well established and may vary depending on the individual characteristics and conditions of the patients. Moreover, the mechanisms underlying the effects of light-based therapy on adipose tissues are not fully understood and require further investigation.

CONCLUSION

Light-based therapy is a potential treatment for insulin resistance that targets adipose tissues *via* photoreceptors. It can also modulate the metabolic functions of (White Adipose Tissue) WAT and (Brown Adipose Tissue) BAT by activating GPCR (G-Protein-Coupled Receptors) signaling pathways that increase lipolysis and thermogenesis. It can affect the circadian rhythm and mood, which are important factors for glucose metabolism and insulin sensitivity. It may offer a novel approach to prevent or treat obesity-related disorders by improving energy balance and glucose homeostasis. Additionally, light-based therapy may have potential side effects or interactions with other treatments or medications that need to be considered.

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Received: 03-Jul-2023, Manuscript No. DCRS-23-22688; **Editor assigned:** 06-Jul-2023, PreQC No. DCRS-23-22688 (PQ); **Reviewed:** 19-Jul-2023, QC No DCRS-23-22688; **Revised:** 26-Jul-2023, Manuscript No. DCRS-23-22688 (R); **Published:** 02-Aug-2023, DOI: 10.35841/2572-5629-23.8.174.

Citation: Tubiana R (2023) Light-Based Therapy to Reduce Insulin Resistance and Improvement of Glucose Metabolism. Diabetes Case Rep. 8:174.