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Influence of photobiomodulation with blue light on the metabolism, proliferation and gene expression of human keratinocytes

Autor: Anja Becker
Institut / Klinik: Zentrum für Medizinische Forschung
Doktorvater: Prof. Dr. N. Gretz

Keratinocytes are present in all the layers of the epidermis, the outermost layer of the skin, and are essentially connected to the pathophysiology of skin diseases such as psoriasis and atopic dermatitis, and play a crucial role in skin wound healing. They are the first cells to get into contact with external stimuli and are consequently more amenable to non-invasive treatments such as photobiomodulation (PBM) using blue light. The anti-microbial, anti-inflammatory and anti-proliferative effects of blue light are already used for different medical treatments like psoriasis, neonatal jaundice and back pain. However, little is known about the mechanisms transducing the light induced signals from target molecules over downstream processes and/or gene expression to the biological effects and therefore the aim of this thesis was to examine the photobiomodulatory effect of blue light on the immortalized human keratinocyte cell line HaCaT in detail.

The effect of PBM using blue light is dose dependent. The biphasic dose response curve of proliferation in HaCaT cells is reflected in the gene expression results. The two used dosages of 7.5min (10.35J/cm²) and 30min (41.4J/cm²) of blue light show some similarities in regulated pathways, like production of steroid hormones and induction of cell survival pathways. However, there are some significant differences as for example the level of oxidative stress. Gene expression results show that the oxidative stress dependent Nrf2 transcribed genes were not deregulated for 7.5min (10.35J/cm²) blue light irradiation. However, when increasing the dose to 30min (41.4J/cm²) blue light, Nrf2 transcribed genes were highly upregulated. After activation of AHR with blue light, the dose seems to determine the extent of the downstream effect and therefore the dose dependency seems to be induced by the secondary steps after blue light irradiation, with oxidative stress being one of the most influencing factors. As a summary it can be said that blue light provides us with a promising treatment method for different paradigms with the dose as an important parameter to be selected according to the needs of the patient.