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Influence of blue light on skin models consisting of fibroblasts and keratinocytes

Autor: Natalia Kuch
Institut / Klinik: Zentrum für Medizinische Forschung
Doktorvater: Prof. Dr. N. Gretz

In this project a therapy and a device to treat chronic wounds in diabetics were developed. The therapy is based on photobiomodulation using blue light. The effects of different doses of blue light were first tested in vitro on skin models of keratinocytes and fibroblasts in different models. Here, an enhanced metabolic activity and proliferation could be identified with 10.35 J/cm². With higher fluences (41.40 and 82.80 J/cm²) the opposite effect could be observed: decreased metabolic activity and proliferation were revealed. Further, the experiments were transferred to in vivo testing on rats. Also here, single blue light irradiations with different doses revealed different effects in dependence of the dose, as is typical for photobiomodulation, described as the Arndt-Schulz-curve. Effects could be seen regarding the CRP, showing a reduction of inflammation with lower fluences, while higher fluences did not have an effect on CRP. Gene expression revealed changes in the inflammatory response, where certain anti-inflammatory and pro-inflammatory pathways were deregulated. The inflammatory response seemed to be enhanced, driving forward the overall inflammation response. This could be confirmed by long-term irradiation of diabetic rats, where wounds treated with light therapy healed faster than non-treated wounds. Also, inflammatory pathways were deregulated, proliferation and differentiation was up-regulated, formation of fibers and neurons and remodeling of granulation tissue was enhanced.
To be able to apply the findings on patients, a device was developed, which emits blue light, regulating wound closure. This device was tested in vitro first, where single irradiations showed the same effects as with the lamp used for preliminary experiments. During in vitro testing, heat development posed a problem and a risk of burns. Therefore the device was programmed to use pulses instead of continuous irradiation. Thereby the heat development could be reduced from a maximum temperature of 52°C to 37°C with pulses of 30 s. This scheme was tested on porcine skin, where no negative effects could be seen. The light schedule was again tested in vitro, showing a shift to higher fluences to achieve the desired effects. In vivo testing unfortunately did not lead to positive results, probably due to involvement of a wound dressing, changing the homogeneity of the irradiation area.
Nevertheless, the project led to interesting outcomes, which are ready to be applied in a clinical trial and could improve healing of chronic wounds.