Introduction

As reported recently, 233 nm radiation emitted by a spectrally pure UVC LED source shows sufficient bactericidal properties at an applied dose between 20 and 80 mJ/cm² [1]. In ex vivo human skin and skin models, the formation of epidermal DNA lesions at bactericidal doses was minor compared to one tenth of the minimal erythema dose of UVB light. This can be attributed to the strong absorption for wavelengths below 240 nm in the upper non-keratinized dermal cell layers. Furthermore, the radical formation was far lower than for a dose equivalent to a stay of 20 min outdoors, as shown on reconstructed human epidermis (RHE).

To assess the influence of 233 nm wounds for wound healing application we simulated wounds by skin barrier disruption. For this, we detached the stratum corneum from the viable epidermis in ex vivo human skin mechanically. After irradiation of the skin with a wavelength of 233 nm, we screened the tissue for the formation of DNA damage.

In conclusion, 233 nm LED irradiation at the studied dose could be suitable for skin antisepsis by using FLIM. We demonstrated this melanin gradient by using FLIM. Here, the mean lifetime $T_\text{m}$ shows an inverted correlation with the local melanin concentration.

Barrier-disrupted skin ex vivo: DNA damage and radical formation

Characterization of barrier-disrupted (BD) skin

Measurement of stratum corneum thickness by 2-photon microscopy

- Formation of radicals for 40 mJ/cm² at 233 nm was approximately half as low than for a dose of VIS-NIR equivalent to a stay of 20 min outdoors, as shown on RHE.

Measurement of transepidermal water loss (TEWL)

- Formation of epidermal DNA lesions for 40 mJ/cm² at 233 nm was minor compared to one tenth of the minimal erythema dose of UVB light (3 mJ/cm²) in both, RHE and ex vivo human skin.

DNA damage and radical formation in ex vivo skin and RHE

EPR spectroscopy: Radical formation

- Formation of radicals for 40 mJ/cm² at 233 nm was approximately half as low than for a dose of VIS-NIR equivalent to a stay of 20 min outdoors, as shown on RHE.

Immunohistochemistry: DNA damage

- Formation of epidermal DNA lesions for 40 mJ/cm² at 233 nm was minor compared to one tenth of the minimal erythema dose of UVB light (3 mJ/cm²) in both, RHE and ex vivo human skin.

DNA damage in different skin types ex vivo

2-photon fluorescence lifetime imaging (FLIM) of cryo-histological slices

- The positive control (UVB 3 mJ/cm²) showed a 2-fold increased CPD formation for skin type I-III in comparison to skin type IV-VI. For 233 nm (40 mJ/cm²) we could detect slightly higher CPD formation in skin types I-III, while for 222 nm (40 mJ/cm²) no differences were observed. This phenomenon could be explained by the fact that far-UVC light only penetrates the upper epidermal layers. The difference of melanin concentration between fair and dark skin types is lower in these layers as compared to the basal layer which is reached by UVB light.

Conclusion

In conclusion, 233 nm LED irradiation at the studied dose could be suitable for skin antisepsis and indoor air decontamination in the presence of humans. Differences in skin type and barrier condition should be considered for the application of the LED system.

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References