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Modification of the Dermal Barrier Function by Atmospheric Pressure Plasma

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The outer layer of mammalian skin, the stratum corneum (SC), acts as the main barrier to protect the body from environmental influences and potentially hazardous substances. However, the skin is a popular route for drug delivery and especially newly developed drugs, which are often large and poorly water-soluble molecules, may benefit from dermal delivery.

The goal of our research is to enable cutaneous drug delivery by an efficient, safe and pain-free method using cold atmospheric plasma (CAP). It has recently been shown that CAP can be employed to enhance skin penetration of various substances [1, 2]. The beneficial properties of CAP sources similar to those used in our experiments have already been used in wound care [3]. Therefore, future CAP treatments, e.g., of skin disorders, may distinctly benefit from synergistic effects.

In our work, plasma-assisted permeabilization of model systems (e.g., isolated human SC) by custom-made CAP sources is tested using easily detectable model pharmaceuticals differing in size from below 1 nm to 500 nm. Electrical resistance measurements and the results of Franz diffusion cell studies with isolated human SC show an alteration of the barrier function as to reduced electrical resistance values and enhanced permeation of fluorescent marker molecules which is dependent on the treatment duration. While a single treatment for 90 s at 212±20 $mW \cdot cm^{-2}$ did significantly reduce SC electrical resistance, it did not significantly alter permeation of fluorescent model drugs as compared to control samples. Two 90 s CAP-treatments did both decrease the electrical resistance and significantly facilitate permeation of marker molecules with a molecular weight of up to 500 kDa (Stokes radius ~14,7 nm).

These results will on the one hand contribute to the safety assessment of CAP-sources used in medical care but also offer further insight into the innovative field of CAP-assisted drug delivery.

References

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