A new flexible volume DBD device for the treatment of diabetic foot ulcers

In vitro efficacy and safety of a new flexible volume DBD device for the treatment of diabetic foot ulcers

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Diabetic foot ulcers are common complications of diabetes mellitus and greatly increase the risk of infection or subsequent amputation. A novel method to decrease the likelihood of infection and to help cure ulcers is cold atmospheric plasma. We developed and tested a new flexible volume Dielectric Barrier Discharge (vDBD), which produces plasma in ambient air. The device is 5 cm in diameter and can be applied as a plaster following the contours of the skin. The plasma is therefore easy to apply and the plasma discharges are created at even distances to the skin, which acts as a counter electrode.

The bactericidal effect was tested on *Staphylococcus aureus* on agar, in collagen matrices and on human skin in vitro. Safety was monitored by measuring cellular activity in skin biopsies, after multiple daily treatments. To optimize treatment, the plasma parameter pulse duration (µs), the treatment time, water content of the samples, contact area and distance between plaster and surface were varied.

The vDBD was highly efficient within 60 sec when used on bacteria on agar plates. In order to quantify the bactericidal effect in relation to the different variables, bacteria were treated in a collagen matrix. High reduction in collagen matrices was reached in 1-2 minutes of treatment and depended on the amount of liquid present and on absence of buffering. Varying pulse duration had a minimal effect on bacterial reduction. Plasma treatment of bacteria was also efficient on the epidermal side and slightly less efficient on the dermal side of skin. Plasma did not affect skin viability when used for 1-2 min, with contact or at short distance. Repeated treatments of up to 4 times slightly lowered skin viability. Optimal settings from this study will be used to treat diabetic foot ulcers for ten daily treatments with vDBD plasma. With the newly developed flexible plasma plaster we were able to kill bacteria on skin, without affecting viability of dermal cells.

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