Intense Ultrasound (IUS) in Dermatology – an *in-vitro* evaluation of a new approach for precise microsurgery of the skin

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Background and Objective: We investigated the possibility to induce precise and predictable thermal damage patterns in human skin with a newly developed Intense Ultrasound (IUS) device.

Materials and Methods: Preliminary studies included pre-clinical experiments with tissue and biophysical simulations. A wave propagation model and bioheat equation was employed to identify the appropriate range of IUS parameters for the creation of thermal damage patterns in human skin. Experiments were performed on post-mortem human skin samples *in-vitro*. For this study 7.5 MHz and 10 MHz transducers with nominal acoustic output powers of 25 and 45 Watts, respectively, were used. Exposure times ranged from 50 to 200 ms. Thermal damage patterns in the tissue were histologically assessed with a Nitro Blue Tetrazolium Chloride (NBTC) assay.

Results: There was good quantitative correspondence between the predicted and histological thermal damage profile. By specific variation of treatment exposure parameters like exposure time and ultrasound frequency the depth and extent of thermal damage could be controlled. Thermal lesions were typically cone shaped and as small as one millimeter in diameter. By choosing the appropriate settings it was possible to confine the lesions to the deep reticular dermis without thermal damage of the overlying papillary dermis and epidermis Additionally there was no active surface cooling used in this study. With an increase in exposure time the lesions increased in diameter and length inducing thermal damage to the papillary dermis and epidermis.

Conclusion: IUS is a new and promising tool for the creation of precise thermal damage patterns within fractions of a second. This energy source can be useful for a wide array of non-invasive dermatological and micro surgical applications.