

Activities of human cells are modulated by non-thermal atmospheric pressure plasmas

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Non-thermal plasma consists of components such as charged particles, reactive oxygen and nitrogen species (ROS/RNS) including bioactive substances (e.g. OH, NO) as well as radiation (ranging from IR to UV), and free electrons[1]. Due to recent advances in the development of non-thermal plasmas sources, the treatment of living matter with a blend of various plasma components became possible opening numerous possibilities for plasma to influence cells on a molecular/genetic level. Non-thermal plasmas has recently been shown to have broad application potential and therefore promise improvement in treating infected or chronic wounds, superficially skin infections and other demanding skin diseases. While lots of data exists about the killing of microorganisms as well as mammalian cells, the plasma-mediated activation of human cells still remains to be investigated. The aim of this work was to analyze plasma-mediated activation of human cells of different origin (skin, connective tissue and immune system). Therefore human keratinocytes (HaCaT), fibroblasts (MRC5) and immune cells (Jurkat T-cells and THP1 monocytes) were investigated by genomic and proteomic approaches.

Applying a 84 genes wound healing panel the up or down regulation of different genes (ECM and adhesion, growth factors and signaling molecules, inflammatory cytokines and chemokines,) after plasma treatment could be detected. Furthermore, employing liquid chromatography and mass spectroscopy, we were able to identify more than three thousand human proteins, some confirmed by several blotting techniques. The identified proteins displayed a wide range of molecular functions (e.g. antioxidant activities) and a broad spectrum of biological processes (e.g. regulation of cell cycle; cell signaling).

Investigating the cellular responses to non-thermal plasma treatment, we were able to identify several cell specific genes and proteins, which were activated after plasma treatment. Especially cell signaling and pro-proliferative signal molecules were activated after short term plasma treatment indicating stimulatory effects of non-thermal plasmas. However, while all types of cells showed a comparable pattern of activated molecules after plasma treatment, there are some differences in the cellular reactions, displaying diverse sensitivities of the investigated cells towards non-thermal plasma treatment.

[1] K.-D. Weltmann, M. Polak, K. Masur, T. v. Woedtke, J. Winter, and S. Reuter, Contributions to Plasma, Physics, 2012.

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