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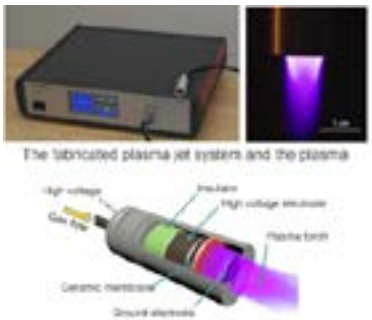
Non-thermal air plasma in skin wound healing

Non-thermal plasma (NTP) is a partially ionized gas generated from a flow of neutral gas in a locally high-strength electric field, while the gas remains at atmospheric pressure and near ambient temperature. Due to its non-specific antimicrobial properties, NTP represents an effective tool for skin disinfection and treatment of chronic wounds and other skin pathologies. Generally, the underlying biological effects of non-thermal plasma are caused by accumulation of ROS /RNS species and modulation of cellular processes related to redox signaling. We have previously demonstrated NTP system generating atmospheric pressure air plasma that shown antibacterial effects and improved the healing efficacy of acute skin wounds in rats and small animals. In addition, repeated application of NTP remarkably improved the healing of chronic wounds of various causalities in veterinary medicine in small animals and sport horses. In the recent study, we analyzed the effect of NTP on the healing of the full-thickness skin wound model in streptozotocin induced diabetic rats. The skin wounds were exposed to three daily plasma treatments for 1.5 minutes and were evaluated 3, 7 and 14 days after the wounding by histological and gene expression analysis. NTP treatment significantly enhanced wound contraction on day 7 when compared to the untreated diabetic wounds and control non-diabetic wounds. Gene expression analysis after 7 days revealed an increased expression of an inflammatory marker IL-1b, IL-6, iNos, COX-2 and CCL2 in diabetic wounds, which was significantly reduced after the NTP treatment. On the other hand, the number of CD68+ macrophages and the amount of collagen in the wound area did not differ after the NTP treatment. In summary, the NTP treatment improved the healing efficacy and reduced inflammatory reaction of acute skin wounds in the model of diabetic rats. The obtained results confirm the safety and suitability of NTP applications for the future therapy in patients.



The fabricated plasma jet system and the plasma

Schematic diagram of plasma nozzle. The gas supply was administered through a gas inlet followed by gas ionization in the pores of the ceramic membrane utilizing an electric field between two electrodes. The gas temperature at the tip of the plasma jet was 37– 40°C.

Recent Publications

1. Smolkova B, Lunova M, Lynnyk A, Uzhytchak M, Churpita O, Jirsa M, Kubinova S, Lunov O and Dejneka A (2019) Non-thermal plasma, as a new physicochemical source, to induce redox imbalance and subsequent cell death in liver cancer cell lines. Cellular Physiology and Biochemistry 52(1):119-140.
2. Kubinova S, Zaviskova K, Uherkova L, Zablotskii V, Churpita O, Lunov O and Dejneka A (2017) Non-thermal air plasma promotes the healing of acute skin wounds in rats. Scientific Reports 7:45183.
3. Lunov O, Zablotskii V, Churpita O, Jager A, Polívka L, Sykova E, Dejneka A and Kubinova S (2016) The interplay between biological and physical scenarios of bacterial death induced by non-thermal plasma. Biomaterials 82:71-83.

Biography

Sarka Kubinova has completed her graduation from Charles University, Faculty of Pharmacy, Czech Republic. She has completed her post-graduation from 1st Medical Faculty of Charles University, Czech Republic and started working at the Institute of Experimental Medicine (IEM) of the Czech Academy of Science where she has continued her research. Presently she is working at the IEM as the Head of the Department of Biomaterials and Biophysical Methods.

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