Plasma Medicine Research at the Max-Planck Institute for Extraterrestrial Physics.

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Low-temperature atmospheric plasma devices proved to be efficient tools for the disinfection of medical instruments and premises. Bactericidal effect of plasma irradiation relies on three active agents: ultraviolet light, reactive oxygen and nitrogen species, and charged particles. The fact that these agents affect bacteria and human cells differently in a dosage-dependent manner suggests the possibility of using low-temperature atmospheric plasma irradiation for therapeutic treatment of human tissues. Our group developed a new plasma device, a microwave plasma torch, specifically designed for the therapy of chronic foot and leg ulcers. The laboratory testing of this device (Phase I of the medical device trial) demonstrated that low-intensity plasma irradiation results in significant reduction of bacterial density on solid agar and in liquid media. At the same time, we demonstrate that plasma irradiation at dosages lethal for bacteria does not induce necrotic changes in human blood cells and skin tissue irradiated *ex-vivo.* Our *in vitro* experiments show that plasma irradiation during 1-10 min does not induce high rates of apoptosis (< 10%), but causes temporary cell cycle arrest in human skin fibroblasts and keratinocytes. Clinical trial of the device (Phase II) confirmed bactericidal efficiency of plasma irradiation for chronic wound treatment. Survey that included 120 patients showed that plasma irradiation results in 30 % (median) reduction of bacterial density in the wounded area. At present time, our group is preparing necessary documentation, developing study protocols, and establishing new collaborations for initiating Phase III of the medical device trial.