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Interactions of Low-Temperature Atmospheric-Pressure Plasmas with Cells, Tissues, and Biomaterials for Orthopaedic Applications

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It has been known that, under certain conditions, application of low-temperature atmospheric-pressure plasmas can enhance proliferation of cells. In this study, conditions for optimal cell proliferation were examined for various cells relevant for orthopaedic applications. Plasmas used in our experiments were generated by dielectric barrier discharge (DBD) with a helium flow (of approximately 3 litter/min) into ambient air at atmospheric pressure by a 10 kV～20 kHz power supply. Such plasmas were directly applied to a medium, in which cells of interest were cultured. The cells examined in this study were human synoviocytes, rat mesenchymal stem cells derived from bone marrow or adipose tissue, a mouse osteoblastic cell line (MC3T3-E1), a mouse embryonic mesenchymal cell line (C3H-10T1/2), human osteosarcoma cells (HOS), a mouse myoblast cell line (C2C12), and rat Schwann cells. Since cell proliferation can be enhanced even if the cells are not directly exposed to plasmas but cultured in a medium that is pre-treated by plasma application, it is surmised that long-life free radicals generated in the medium by plasma application stimulate cell proliferation if their densities are appropriate. The level of free radical generation in the medium was examined by dROMs tests and correlation between cell proliferation and oxidative stress was observed. Other applications of plasma medicine in orthopaedics, such as plasma modification of artificial bones and wound healing effects by direct plasma application for mouse models, will be also discussed. The work has been done in collaboration with Prof. H. Yoshikawa and his group members at the School of Medicine, Osaka University.

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