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Anti-cancer Effects of Plasma Activated Media Produced by Low-frequency- and Microwave-excited Atmospheric Pressure Plasma Jets

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Cold atmospheric plasma (CAP) has been reported to have strong anti-cancer effects *in vitro* and *in vivo*. CAP has been known to induce apoptosis in most cancer cells by treating to cell using direct and indirect treatment method [1 - 4]. There are many reports of apoptosis pathways induced by CAP, but for indirect treatment there is still a lack of fundamental research on how CAP can cause apoptosis in cancer cells. In this study, we applied an indirect treatment method to determine how CAP can induce cancer cell death. First, plasma-activated medium (PAM) was produced by various types of plasma sources such as a low-frequency atmospheric pressure plasma jet (LF-APPJ) and microwave-excited atmospheric pressure plasma jets (ME-APPJs). Plasma properties such as temperature and electron density were estimated using optical emission spectroscopy. Next, the amounts of various reactive species in the PAM produced by various plasma sources were estimated using colorimetric methods and compared. The concentration of NO_2^- and H_2O_2 in PAM cultured with cancer cells was measured and intracellular reactive oxidative stress (ROS) changes were observed using flow cytometry. When PAM was incubated with A549 lung cancer cells, there was little change in NO_2^-concentration, but the concentration of H_2O_2 gradually decreased after 30 min. While the intracellular ROS of A549 cells increased rapidly at 2 hours, there was no significant change in that of PAM-treated normal cells. Furthermore, PAM had a significant cytotoxic effect on A549 cells but had little effect on normal cell viability. Using flow cytometry we confirmed that apoptosis of A549 cells occurred following cell cycle arrest and caspase-3/7 activation. These results suggest that among various reactive species generated by PAM, hydrogen peroxide plays a key role in inducing cancer cell apoptosis. In addition, we investigate the effectiveness and prospect of PAM prepared by LF-APPJ and ME-APPJ for cancer therapy.

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