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Cell death mechanisms by plasma activated medium and plasma activated Ringer's lactate solution

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Medical applications of low temperature plasma in cancer therapy have attracted attention. We have previously developed plasma activated medium (PAM) [1] and plasma activated Ringer's lactate solution (PAL) [2] for cancer treatment. It has been demonstrated that both PAM and PAL show selective killing of cancer cells, however, their mechanisms remain to be elucidated.

To understand interactions between biochemical network and PAM on glioblastoma cells, we investigated gene expression, signal transduction, and metabolome. We first performed western blotting experiments of PAM-treated glioblastoma cells to investigate signal transduction of PAM-treated glioblastoma cells. We found that PAM downregulated both PI3K-AKT signaling pathway and RAS-MAPK signaling pathway. Next, we performed micro array experiments and quantitative real-time PCR experiments of PAM-treated glioblastoma cells to investigate their gene expression. We found that PAM upregulated genes related in GADD45 signaling [3]. Finally, we analyzed metabolomic profiles of intracellular metabolites of PAM-treated glioblastoma cells using capillary electrophoresis mass spectrometry. We found that PAM inhibited the glycolysis pathway and enhanced the pentose phosphate pathway on PAM-treated glioblastoma cells [4].

We found some differences in cell death mechanisms between PAM-treated glioblastoma cells and PAL-treated glioblastoma cells. PAL induced less intracellular reactive oxygen species on glioblastoma cells than PAM did. We found that PAM induced oxidative stress-dependent cell death, while PAL induced oxidative stress-independent cell death. We are further investigating gene expression, signal transduction, and metabolome on PAL-treated glioblastoma cells to comprehensively understand cell death mechanisms of PAL-treated glioblastoma cells.

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