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The cell activation phenomena in the cold atmospheric plasma cancer treatment

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Cold atmospheric plasma (CAP) showed a promising application in cancer treatment through dozens of demonstrations. The activation phenomenon of the CAP-treated cancer cells is a new concept in plasma medicine. In plasma medicine, a basic concern is the role of CAP during the treatment. Our recent experimental evidence demonstrated that CAP plays at least two important roles during the cancer treatment in vitro. The first role is providing abundant reactive species in the extracellular environment such as in medium. The second role is the CAP-triggered activation of the cancer cells, which may be a unique feature of CAP treatment. Despite the CAP-triggered activation will not cause noticeable cytotoxicity on the cancer cells, such activation drastically decreases the threshold of these cancer cells to the cytotoxicity of reactive species particularly ROS. A quick sensitization and slow desensitization are two features of such activation. The activation started since the 2nd second in CAP treatment. In contrast, a full de-sensitization process of the activated cancer cells last 5 hours after a CAP treatment. This discovery drastically changes our previous understanding of the anti-cancer mechanism of CAP treatment. The activation phenomenon during the direct CAP treatment explains the stronger anti-cancer effect of a direct CAP treatment compared with an indirect CAP treatment based on the CAP-treated solutions. Recently, we demonstrated that the flow rate of helium, the discharge voltage and the discharge frequency can affect the activation state of the CAP jet-treated cancer cells. Among the three basic operational parameters, a medium discharge voltage (3.78 kV) can cause the strongest activation effect. In addition, we recently also demonstrated that a nanosecond-pulsed magnetic field generator (NMF) could sensitize the melanoma cell line B16-F10 to the cytotoxicity of a ROS, H2O2. The NMF treatment alone did not noticeably inhibit the growth of melanoma cells.

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