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Photodynamic Effect of Single-walled Carbon Nanotubes and its potential for cancer phototherapy

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Single-walled carbon nanotubes (SWNTs) are known to be classified into two types, metallic and semiconducting ones (m-SWNTs, s-SWNTs), on the basis of their chiralities. SWNTs reveal photothermal (PTE) and photodynamic effects (PDE), which result in generation of heat and reactive oxygen species (ROS) such as singlet oxygen ($^1O_2$) and superoxide anion ($O_2^{\bullet -}$), respectively. While PTE of SWNTs has received much attention for cancer therapy, a recent report suggests that PDE of carbon nanotubes can be used for protein inactivation through photogeneration of superoxide anion[1]. In this study, we enriched m- and s-SWNTs by a gel chromatography and evaluated their PTE and PDE in detail. Under near-infrared laser irradiation, s-SWNTs generated both ROS much more efficiently than m-SWNTs, showing that s-SWNTs had higher PDE. For cell studies, s-SWNTs were successfully stabilized with a natural dispersant, high-density lipoprotein (HDL). HDL-stabilized s-SWNT did not show significant cytotoxicity, and caused photo killing of cancer cells through $^1O_2$ generation like other photosensitizers under near-infrared irradiation. This is the first example of observing cancer cell killing by photodynamic effect of SWNT.

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