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PLENARY

Nanoparticle-based Cancer Therapy

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Abstract

Advances in Nanotechnology have led to the development of a variety of nanomaterials that are changing the way cancer therapy is carried out. A particularly important example is nanoparticle that can carry cargo to tumor. We are using mesoporous silica nanoparticles (MSNs) for cancer therapy. MSNs contain thousands of pores that provide storage space for anticancer drugs. These materials are biocompatible and safe. In addition, we have recently introduced biodegradability into MSNs.

We have shown that MSNs exhibit excellent tumor targeting capability in two different animal model systems (chicken egg tumor model and mouse xenografts). This tumor targeting capability is partly due to its small size; these nano-sized particles can accumulate in tumor due to leaky tumor vasculature. In addition, we have carried out surface modifications to attach ligands that bind receptors present on the surface of cancer cells. For example, folate was attached to the surface that enables binding to folate receptors overexpressed on cancer cells.

We have also conferred controlled anticancer drug release capability to MSNs in collaboration with Fraser Stoddart and Jeff Zink. This was accomplished by attaching nanovalves at the opening of the pores. Rotaxanes and pseudorotaxanes are used to prepare nanovalves. These chemical compounds consist of a stalk and a moving part. When the moving part is close to the pore opening, the nanovalve is closed. On the other hand, when the moving part is located away from the pore opening, the nanovalve is closed. In this way, the nanovalve provides an open and close function so that controlled release of anticancer drugs can be carried out.

Light activated nanovalves were developed by incorporating azobenzene into nanovalves. Azobenzene changes conformation upon light exposure and this conformational change opens the nanovalve releasing anticancer drugs in a power and exposure time dependent manner. More recently, this system was modified by incorporating two-photon dyes that can capture energy from two-photon light and transfer to azobenzene to drive the release of anticancer drugs. This enables the system to work with tissue penetrating two-photon light.

We have also developed nanoparticles that respond to oscillating magnetic field. This system was developed using MSNs that contain iron oxide core. Because of superparamagnetic property of iron oxide, the internal temperature of such nanoparticles increases when exposed to oscillating magnetic field. This temperature increase drives opening of nanovalves that are particularly designed for this purpose.

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Development of nanoparticles that respond to external cues such as light and magnetic field may change the way cancer therapy is carried out. Implications on the future of cancer therapy will be discussed.

Keywords

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References

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