Synthesis and evaluation of astatine-211 labeled gold nanoparticles for alpha nano-brachytherapy

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Much attention has been drawn to the α-emission radiotherapy with regard to its potential cancer therapeutic efficacy. Astatine-211 (^{211}At), with a comparatively short half-life of 7.2 h, is able to emit alpha particles within a few cell diameters with high energy, which can damage cancer cells in a high relatively biological effectiveness. ^{211}At has similar characteristics to the iodine, which can rapidly diffuse throughout the body and accumulate in thyroid gland.[1] Therefore, high accumulation of ^{211}At in tumor tissue is necessary. Brachytherapy is a form of radiotherapy where a radiation source is placed to the area requiring treatment. The tumor can be treated with very high doses of localized radiation whilst reducing the damage to surrounding healthy tissues by using brachytherapy. Since ^{211}At has high affinity to gold[2], we planned to develop a novel cancer treatment by intratumoral injection of ^{211}At-labeled gold nanoparticles to cancer cells (Fig.1).

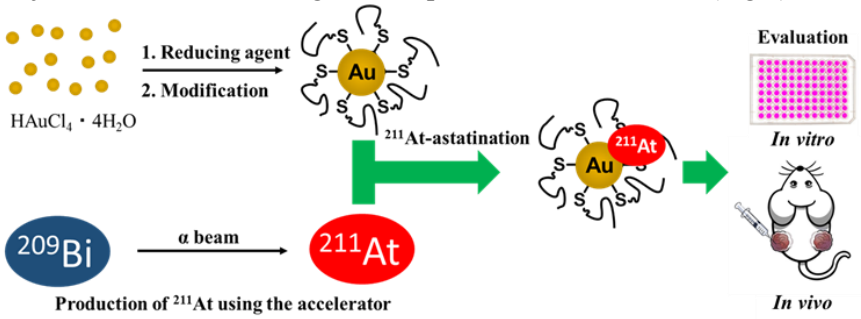

Fig.1 Schematic representation of this research

We synthesized different sizes of poly (ethylene glycol) methyl ether thiol modified gold nanoparticles (AuNP-S-mPEG) and astatinated pegylated AuNPs (^{211}At-AuNP-S-mPEG). Astatination quantitatively proceeded in all sizes of AuNP-S-mPEG. Cytotoxicity and internalization were evaluated *in vitro* and anti-tumor effect were evaluated by using rat tumor model (C6 glioma). *In vitro* experiment showed that the uptake of nanoparticles can significantly affect the cytotoxicity. *In vivo* studies revealed that after intratumoral administration, ^{211}At-AuNP-S-mPEG have significant anti-tumor effect. The results may help to optimize the design of alpha-particles therapy drugs, which are suitable for nano-brachytherapy.

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