Ultrasmall near-infrared gold nanoclusters

AuNCs

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Chemical name:	Ultrasmall near-infrared gold nanoclusters	
Abbreviated name:	AuNCs	
Synonym:		
Agent category:	Metal	
Target:	Non-targeted	
Target category:	Non-targeted	
Method of detection:	Optical, near-infrared (NIR) fluorescence imaging	
Source of signal:	Gold (Au)	
Activation:	No	
Studies:	• *In vitro* • Rodents	No structure is currently available in PubChem.

Background

[PubMed]

Optical fluorescence imaging is increasingly used to monitor biological functions of specific targets (1-3). However, the intrinsic fluorescence of biomolecules poses a problem when fluorophores that absorb visible light (350–700 nm) are used. Near-infrared (NIR) fluorescence (700–1,000 nm) detection avoids the background fluorescence interference of natural biomolecules, providing a high contrast between target and background tissues. NIR fluorophores have a wider dynamic range and minimal background as a result of reduced scattering compared with visible fluorescence detection. They also have high sensitivity, resulting from low infrared background, and high extinction coefficients, which provide high quantum yields. The NIR region is also compatible with solid-state

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optical components, such as diode lasers and silicon detectors. NIR fluorescence imaging is becoming a noninvasive alternative to radionuclide imaging in small animals (4, 5).

Gold nanoparticles have been studied as molecular imaging agents because of their bright NIR fluorescence emission around 800 nm and low toxicity (6, 7). They can be tuned to emit in a range of wavelengths by changing their sizes, shapes, and composition, thus providing broad excitation profiles and high absorption coefficients. They can be coated and capped with hydrophilic materials for additional conjugation with biomolecules, such as peptides, antibodies, nucleic acids, and small organic compounds for *in vitro* and *in vivo* studies. Gold nanoparticles are approved by the United States Food and Drug Administration for treatment of patients with rheumatoid arthritis. Gold nanoclusters (AuNCs) possess an ultrasmall size of ~2 nm compared with quantum dots (QDs, ~20 nm) (8). AuNCs are less likely to have high reticuloendothelial system accumulation. AuNCs have been studied as agents for NIR fluorescence imaging of cancerous tissues through the enhanced permeability and retention effect (9).

Related Resource Links:

- Chapters in MICAD (Gold imaging)
- Clinical trials (Gold nanoparticles)
- Drug information in FDA (Gold nanoparticles)

Synthesis

[PubMed]

Wu et al. (9) reported the synthesis of AuNCs by addition of 0.5 ml NaOH (1 M) to a solution of 10 ml $HAuCl_4$ (1 mM) containing bovine serum albumin (5 mg/ml) under vigorous stirring for 12 h at 37°C. AuNCs had a hydrodynamic diameter of 2.7 nm in phosphate-buffered saline as measured with dynamic light scattering.

In Vitro Studies: Testing in Cells and Tissues

[PubMed]

AuNCs exhibited a red fluorescence emission signal (~710 nm) when excited at 465–495 nm (9). AuNCs exhibited high photostability similar to that of QDs.

Animal Studies

Rodents

[PubMed]

Wu et al. (9) performed a series of whole-body NIR fluorescence imaging after intravenous injection of 0.5 mg AuNCs in normal nude mice ($n = 3$) and in nude mice bearing MDA-MB-45 tumors ($n = 3$). In normal nude mice, the fluorescence signal was

immediately visualized in the superficial vasculature. AuNCs remained in the circulation at 5 h after injection. Strong fluorescence intensity was observed in the liver and urinary bladder at 1, 2, and 4 h after injection; gradual clearance was observed, but fluorescence was still visible by 24 h. *Ex vivo* fluorescence imaging showed that the liver had the highest signal intensity at 5 h after injection with 29% injected dose (ID)/cm^2, followed by the kidney (18% ID/cm^2), skin (13% ID/cm^2), spleen (13% ID/cm^2), intestine (11% ID/cm^2), heart (6% ID/cm^2), lung (5% ID/cm^2), and muscle (4% ID/cm^2) at the same time point. In mice bearing MDA-MB-45 tumors, fluorescence intensity in the tumor was clearly visualized at 1 h after injection, whereas signal intensity from other tissues was low. The fluorescence intensity in the tumor increased with time, with a tumor/muscle ratio of 15 at 6 h after injection. Thus, the leakiness of the tumor allows accumulation of AuNCs within the tumor by passive diffusion.

Other Non-Primate Mammals

[PubMed]

No publication is currently available.

Non-Human Primates

[PubMed]

No publication is currently available.

Human Studies

[PubMed]

No publication is currently available.

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