Chemistry of Contrast Media

Particles and Polymers

Advances in Particles and Polymers: Multimodality Contrast Materials

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Learning Objectives:
Provide the correct answers to the following questions:

- What combination of imaging modalities is most commonly used?
- For which disease conditions have multimodal particles shown to be better than unimodal particle cocktails?
- Have multimodal particles entered the clinic and if so, for what application?

During recent years, it has become fashionable to develop so-called “multimodal” particles and polymers. These contrast agents contain two or more entities that can be detected with different imaging modalities. Most useful are agents that contain a fluorescent tag. In that way, the in vivo imaging findings can be validated with histology. Others have developed contrast materials that can be detected with different non-invasive vivo techniques (MRI, CT, ultrasound, SPECT, and PET): examples include PFOB particles and capsules, paramagnetic quantum dots and gold particles, radiolabeled MR contrast agents, paramagnetic PET tracers, and so on. While most studies have provided proof-of-principle of multi-detection, the true benefit of the multimodal approach still needs to be demonstrated. Clinical translation has not yet occurred, and the question often arises: why do we need to use multiple imaging modalities? Shouldn’t we just choose the best imaging technique for that particular application (i.e., atherosclerotic plaque imaging), and optimize our contrast material for maximum sensitivity using that particular imaging technique (i.e., CT vs. MRI). Consider for instance a gold-coated superparamagnetic iron oxide CT/MRI contrast agent. Is this multimodal agent a compromise for sensitivity, i.e., are they less sensitive then unimodal agents with the same overall structure? If so, why can’t we synthesize 2 different particles with optimized sensitivity (i.e., separate iron oxide and gold nanoparticles) and administer them as cocktails. The answer is that most likely the biodistribution and blood half-life of the two particles will be different, so that the two imaging techniques will give 2 different pictures. During this educational session, examples will be shown for several types of multimodal particles and polymers, both for targeted and non-targeted applications. The main thread of the presentation will be whether or not multiple imaging modalities are really needed for improved diagnosis of a certain condition, or if choosing the most sensitive and specific single technique would be a better option.

Relevant Publications:

1. E.T. Ahrens, J.W.M. Bulte. Tracking immune cells in vivo using magnetic resonance imaging. Nat. Rev. Immunol. 13, 755-763 (2013).
2. A.K. Srivastava, J.W.M. Bulte. Seeing stem cells at work in vivo. Stem Cell Rev. 10, 127- 144 (2014).
3. J.W.M. Bulte, A.H. Schmieder, J. Keupp, S.D. Caruthers, S.A. Wickline, G.M. Lanza. MR cholangiography demonstrates unsuspected rapid biliary clearance of nanoparticles in rodents: Implications for clinical translation..Nanomedicine, in press. doi: 10.1016/j.nano.2014.05.001