Nano/micro sized contrast agents for imaging applications: opportunities & challenges

Alessandro Maiocchi
Bracco Imaging

Medical imaging is the technique and process used to create images of the human body (or parts and function thereof) with the goal of enabling early diagnosis or reveal and examine diseases. Consequently, nano- & micro-technology in medical imaging reefers to the use of nano & micro-particles as contrast agents for in-vivo diagnosis in combination with different medical imaging modalities like Computed tomography (CT), ultrasound (US), magnetic resonance imaging (MRI), positron emission tomography (PET) and single-photon emission computed tomography (SPECT).
Recently other new imaging modalities are emerging for a potential larger clinical applications like Optical Imaging (OI) and Photoacustic Imaging (PAI).
The increased attention in the development of multifunctional nano & micro sized imaging probes is principally due to their versatilities offered over the conventional contrast agents. In fact, the availabilities of several surface chemistries, unique magnetic properties and tunable energy absorption and emission properties make the nanoparticles an exciting technology opportunity for all the imaging techniques. However, among others issues, the clinical interpretation of an imaging signal coming from nanoparticles may be extremely cumbersome. Indeed the whole signal could be the result of several mixed mechanisms where both active and passive interactions with heterogeneous tissue localizations can affect the total signal in an unpredictable way. The translation of the registered static or dynamic signal to an information with a clear diagnostic value is not straightforward. In contrast with the considerable amount of papers published on the use of nanoparticles for functional and molecular imaging, currently there are only two remarkable examples of nano-sized contrast agents available on the clinical market. The first example is a sulfur based colloidal formulation of ^{99tm}Tc used for the staging of breast cancer and, more recently, melanoma. The second one is represented by the off-label use of Ferumoxitol as an MRI angiography agent in patients with renal failure who cannot be given gadolinium and in clinical trials for the characterization and mapping of metastatic lymph nodes and hepatic masses.
Differently from the complexities encountered in the development of nano-sized systems for imaging purpouses, micro-sized systems like micro-bubbles are largely used as contrast agents for Ultrasound imaging and their use is continuously growing in the clinical practice. Their clinical value has been established and offer several translation advantages due to their simplified biodistribution properties triggered by their blood pool behavior and low half-time. Moreover, with micro-bubbles, active targeting strategies may be finely tuned and can be efficiently used to probe virtually any abnormality in the membrane composition of endothelial cells. On this respect the information regarding organ perfusion and endothelium aberrations are derived independently and can be used to stratify pathological tissues. The aim of this talk is to provide an update on the latest advances designed to overcome the main challenges encountered in the translation of nano- & micro-sized particles for medical imaging applications.