

The use of nano& micro sized systems in medical imaging: perspectives and limitations

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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, nanotechnology in medical imaging refers to the use of nanoparticles (NPs) as contrast agents for in-vivo diagnosis in combination with different medical imaging modalities. The increasing attention in the development of multifunctional nanomaterials is principally due to NPs versatility offered over the conventional agents. In fact, the availabilities of several surface chemistries, unique magnetic properties and tunable energy absorption and emission properties make the nanoparticles an exciting opportunities on the whole imaging techniques. Nevertheless the translation to nano-sized system as carrier of imaging agents is still rather complicated. In contrast to the considerable amount of papers published on the use of nanoparticles for functional and molecular imaging, there are only a very few nanoparticle-based contrast agents which really seem relevant from a clinical point of view. Although SPIO and USPIO have been approved for clinical use in the past, currently they are no longer available on the market as intravenous imaging agents. The current clinical contrast enhanced imaging applications are based on relatively fast procedures in which, after intravenous administration of a small molecule based contrast agent, the patient is imaged in a quite short time. On the contrary, the use of nano-sized agents increases the time required to complete a diagnostic procedure, particularly when the analysis of a wash-in/wash-out curve in a pathological tissue is needed. Moreover the uptake of a nano-sized contrast agent could be the result of several mechanisms, where both active and passive interactions and different localizations in the tissue, are mixed together contributing to the whole signal. It is also important to underline the relevance of toxicity or adverse reactions occurrence in the usage of contrast agents because, differently from therapeutics, the level of practical acceptance of toxicological events is very low for a diagnostic procedure. Nevertheless also taking all the above into consideration, there are several possible imaging applications where a nanoparticle-based contrast agent can be used after a fine tuning of its pharmacokinetic, biodistribution and elimination properties.

However more than for diagnostic purposes, the imaging-guided therapy applications seems to offer better opportunities for clinical translation, particularly in the contest of imaging-guided surgery where nano-colloids are already in clinical use for sentinel lymph node detection/resection. In this context the whole application scenery changes as the target product profile is completely different. The aim of this talk is to analyze which are the main challenges in the engineering of nanoparticles for medical imaging application in order to address the development of nano-sized system for clinical purpose. To do this, the main advances and drawbacks of preclinical and clinical nanoparticles are evaluated with particular attention to their physico-chemical features aimed to control pharmacokinetics improving in vivo targeting properties and safety.