

Diagnostic nanoparticles for drug delivery, cell tracking and tissue engineering

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Diagnostic nanoparticles have been proposed as imaging agents for decades. However, due to their different pharmacokinetic properties, they should not be used for the same indications as small molecule diagnostics. In this talk, I will present three application areas where diagnostic nanoparticles are powerful:

1. Drug delivery: Nanomedicines need to overcome important biological barriers and rendering them theranostic can help us to better understand tissue compartmentalisation and maximise their accumulation at the target. It will also be critically discussed to what extent accumulation characteristics need to be addressed with nanotheranostics in a clinical context or whether companion diagnostics might be cheaper and easier to implement.
2. Trigger-responsive theranostics: Trigger-responsive nano- and microparticles can be used to open biological barriers and to disintegrate cells, helping us to deliver drugs and nucleic acids to tumours and the brain. This concept will be demonstrated using phase-converting nanodroplets, nano- and microbubbles, all of which respond to ultrasound activation. It will also be shown that loading cells with nanobubbles in combination with super-resolution ultrasound detection could become a unique method to localize them in deep tissues.
3. Tissue engineering: Tissue engineered constructs often contain (degradable) scaffolds. Here, the use of imageable polymers or the labelling of scaffolds with superparamagnetic iron oxide nanoparticles allows the non-invasive monitoring of scaffold degradation and remodelling, which is very important for clinical translation as it helps to assess acceptance and integrity of the implant. This will be demonstrated for biohybrid vascular implants and heart valves.

These examples show that exploiting the specific properties of diagnostic nanoparticles opens up new diagnostic and therapeutic possibilities that are very different from those of small molecule diagnostics and therapeutics.