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Functional Degradable Polymers for Advanced Applications in Clinical Imaging

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Introduction

Medical devices and tissue engineering applications are largely relying on polymeric biomaterials that are intrinsically not visible under the clinical imaging modalities currently in use. In this contribution, we report on various advanced functional polymers, especially polyesters, that have been designed and synthesized to make them visible under scanner (X-ray) or medical resonance imaging (MRI).

Experimental Methods

Various strategies have been followed to yield polymers for clinical imaging. These include functional monomers synthesis and copolymerization (lactones, acrylates), direct polyester post-polymerization modification in solution or surface modification of polymer substrates. All these strategies have been applied to X-ray or MRI contrast agents including iodine, triiodobenzoic acid (TIB), gadolinium complexes (Gd-DTPA or Gd-DOTA) or superparamagnetic iron oxide nanoparticles (SPIONs). Imaging tests have been performed both *in vitro* and *in vivo* to evaluate the visibility, stability and perennity of the visualization.

Results and Discussion

In a first strategy, iodo-poly(ϵ -caprolactone) (PCL-I) and triiodobenzoate-PCL (PCL-TIB) have been successfully prepared via an anionic activation of PCL with LDA as a strong base; followed by nucleophilic substitution with I₂ or TIB. The resulting radiopaque copolymers have been used as additives to prepare implantable degradable biomaterials.¹ A good and stable visibility under micro-computed tomography analyses was confirmed *in vivo* in a rat model

(Fig. 1a). In a second strategy, clickable polyester or poly(meth)acrylates have been synthesized via copolymerization of alkyne functional monomers followed by CuAAC reaction with azido-functional Gd ligands. These MRI-visible copolymers have been used as coatings for surgical meshes and demonstrated their high potential as T1 contrast agents *in vivo*.²⁻⁴ Finally, in a last approach, polymer surfaces, including PLA electrospun fibers, PLA-Plu[®]-PLA threads or PP surgical meshes were efficiently modified with photoreactive Gd ligands (Fig. 1b) or photoreactive SPIONs. The absence of bulk properties modification as well as the ability of these functional surfaces to be imaged under T1 or T2 MRI modalities both *in vitro* and *in vivo* have been assessed.⁵

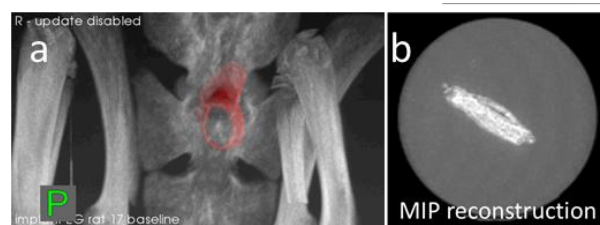


Figure 1. Example of radiopaque copolyester (*in vivo*, μ CT) (a) and of MRI visible PLA-Plu[®]-PLA threads (b)

Conclusions

Through various chemical strategies, a family of polymers for clinical imaging of medical implants is proposed.

References

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