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Rapid prototyped nanocomposite magnetic scaffolds for tissue regeneration

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Statement of the Problem: Magnetic feature have been recently incorporated into polymer based multifunctional scaffolds for tissue engineering. The rationale relies on the possibility to deliver, on demand, bio-aggregates such as drugs and growth factors, by switching on and off an external magnetic field. Moreover, cell seeding into these scaffolds may be improved through external magnetic fields. Nanocomposite magnetic scaffolds consist of a thermoplastic polymeric matrix reinforced and functionalized with magnetic nanoparticles (MNP). These composites show a super-paramagnetic behavior, as they magnetize in the presence of a magnetic field in a similar fashion of ferromagnetic materials, but removing the external magnetic field the residual magnetization is almost null.

Methodology & Theoretical Orientation: Iron oxide and iron doped hydroxyapatite MNPs have been incorporated into aliphatic polyester matrix, and these nanocomposites were processed according to rapid prototyping techniques. A multiphysical approach based on magnetic measurements, simulations, mechanical testing and contact angle measurements has been carried out for characterizing these fully interconnected scaffolds. Cell-material interaction has been evaluated *in vitro* through cell assays, while preliminary in vivo behavior has been assessed through animal models.

Findings: Nanocomposite magnetic scaffolds have been successfully processed through rapid prototyping techniques. These scaffolds show a superparamagnetic behavior. MNPs allow to tailor mechanical properties and to improve wettability. Compared to neat aliphatic polyester based scaffolds, an enhancement of cell-material interaction and of tissue regeneration is observed. It seems that this approach is the only one possible to release, on demand, bio-aggregates through an external physical signal.

Conclusion & Significance: Nanocomposite superparamagnetic scaffolds provide very unique features. Used in combination with magnetically labeled cells and/or magnetic functionalized bio-aggregates, these scaffolds allow triggering biological events by using static or dynamic magnetic fields. Custom made superparamagnetic nanocomposite scaffolds have the potential to guide the regeneration process of damaged biological tissues.

Biography

Roberto De Santis received his Mechanical Engineering degree in 1994, PhD in Biotechnology of Dental Materials in 1997 and Master's in Biomaterials in 2001. He is working as Researcher at the Institute of Polymers, Composites and Biomaterials (IPCB) of the Italian National Research Council from 2001. He is Adjunct Professor of Science and Technology of Dental Materials at the School of Dentistry, Faculty of Medicine of Naples "Federico II". He has worked for many years on materials for biomedical applications developing particular skills on the properties of natural tissues, design of prostheses for hard tissues replacements and scaffolds for tissue engineering.

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