Final Report

Project acronym: *PNANO4BONE*

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Coordinator:

Dr. David Duday
david.duday@list.lu
Luxembourg Institute of Science and Technology, 5 avenue des Hauts Fourneaux, 4362 Esch/Alzette, Luxembourg

Publishable project summary

Current scaffolds for regenerative medicine are facing several drawbacks, which are the low proliferation of living cells seeded in the implant, the short duration of drug delivery when drugs are embedded in the scaffold and the impossibility to easily follow the regenerative processes once the scaffold is implanted. The objective of the project is to solve the above mentioned drawbacks by embedding specifically designed nanovectors in the scaffold. The interaction of these nanovectors with tissue-tolerable plasma (ionized gas) will allow promoting the living cell proliferation through the generation of reactive species. This concept has been validated in vivo on bone cells by using mesoporous silica nanoparticles decorated with ultrasmall FeOx nanoparticles and a GlidArc discharge generating a lot of reactive nitrogen species. The inorganic core of the nanovectors will allow the drug release over weeks/months. Gentamicin, a common antibiotic for bone surgery, has been loaded in the mesoporous silica nanoparticles with a high loading ratio. The antibacterial effect of the gentamicin-loaded silica nanoparticles has been validated. The same nanoparticles were not cytotoxic to bone cells. Probes loaded in the nanovectors will allow monitoring the regenerative process with non-invasive imaging technologies. A fluorescent probe rhodamine has been loaded in the mesoporous silica nanoparticles and they were used to localize the nanoparticles in macrophage cells. In addition to these main goals, the improved generation of free radicals in physiological conditions by combining heterogenous nanocatalysts on inorganic nanoparticles and plasma discharges have been demonstrated for hydroxyl radicals. Preliminary results have also be obtained for the generation of nitric oxide free radicals. Several nanocarriers were designed, fabricated and tested including FeOx-decorated mesoporous silica nanoparticles with both wormhole and stellar structures, loaded or not with gentamicin. Several hydroxyapatite nanoparticles with different shape were also decorated with different nanocatalysts and were showing promising results but they were less efficient in generating free radicals in physiological conditions compared with the mesoporous silica nanoparticles. The most efficient nanoparticles were embedded in the glucan-based injectable scaffolds leading to an important increase of bone cell proliferation. The PNANO4BONE approach has been validated in this project for bone regeneration and it could be easily adapted to the regeneration of other tissues and lead to lower therapies' costs in the future.