The influence of the physical and chemical properties of nanofibers on the modification of controlled delivery of bioactive substances in regenerative medicine.

Abstract

This work focuses on the assessment of the impact of physical-chemical properties of nanofibers on the modification of controlled delivery of bioactive molecules in the context of regenerative medicine. In the osteochondral experimental part, implants based on peptide hydrogel with biodegradable particles exhibiting nanofiber morphology were developed and tested *in vivo*. Also, a combined porous implant based on collagen, β-TCP and nanofiber materials enriched with growth factors BMP-2, TGF-β, bFGF and IGF-1 was tested, with the aim to regenerate both the osteogenic and chondrogenic part of the defect, which was successfully confirmed in the experiment. In the context of skin defects, PCL and PVA skin covers were created and tested in vivo, with excellent results in terms of skin defect regeneration. Furthermore, PCL nanofiber carriers were optimized by inserting a polycaprolactam polymer subunit into the polymer structure, thereby improving the biocompatibility of the nanofiber carriers. Further optimization of the carriers took place at the level of functionalization of PCL nanofiber carriers with adhered platelets or encapsulation of platelet lysate into polymer fibers, which achieved variability in the release of bioactive molecules within up to 30 days. At the end of the experimental part, a functional detection system of a nanofiber carrier was created, utilizing a biotin-avidin complex with an attached anti-PTGDS antibody for the detection of cerebrospinal fluid leak. This system can be modified to capture or release bioactive molecules at the defect site, thus regulating the healing process. The obtained results confirm that by modifying the physical-chemical properties of materials, it is possible to effectively control the release of bioactive substances, which opens up new possibilities in the field of regenerative medicine.

Keywords: nanofibers, tissue regeneration, bioactive molecules, controlled release