Biodegradable Functionalized Membrane for Bone and Tissue Regeneration

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Abstract:

Bone defects, whether caused by trauma, malformations, pathological degeneration, cleft palate defects, or medical interventions, often necessitate reconstructive bone augmentation procedures [1]. These treatments typically involve a range of surgical techniques, including the use of bone grafts and barrier membranes [2,3]. Our project addresses this clinical need by developing a next-generation volume-stable barrier membrane made of biodegradable polylactic acid (PLA), enhanced with bioactive nanoparticles (hydroxyapatite, HAp) and bone morphogenetic protein 2 (BMP-2) that supports bone regeneration in the alveolar ridge. We aim at making such membranes personalized, featuring improved mechanical properties, controlled biodegradation and targeted therapeutic effects.

Different methods are tested for shaping the membranes, for instance, electrospinning, dip coating and Volumetric 3D Printing. For ensuring active bio-functionality we have used two types of HAp particles: (1) mesoporous HAp nanoparticles and (2) Mg-Sr doped HAp nanoparticles, which were mixed to the PLA.

Structural characterization *via* SEM with EDX, Raman spectroscopy and FTIR confirmed the membranes desired morphology, composition and functional integration. *In vitro* degradation tests conducted in acidic, basic and physiological pH environments showed membranes in basic medium degrading faster compared to acidic or physiological pH. First *in vitro* cytotoxicity tests showed good biocompatibility with fibroblasts.

With these first results we are getting closer to the overall goal of achieving membranes that support guided bone and tissue regeneration (GBR/GTR) by maintaining stability within defect sites while promoting controlled biodegradation and cellular response. Challenges must be tackled regarding better distribution of particles within the scaffold material, effectively loading the payloads and realizing personalized shapes.

References:

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