Synthetic Polymers for Tissue Engineering

Dr. Elizabeth L. (Hedberg) Dirk

Department of Chemical and Nuclear Engineering
Center for Biomedical Engineering

Current therapies for the repair of large bone defects include grafted tissue either from the patient (autograft) or from cadavers (allograft). Unfortunately, each of these materials has its own associated limitations. As neither the autograft nor the allografts is ideal, there is a strong clinical need to develop superior alternatives to these methods. Recent advances in tissue engineering have focused on the use of biodegradable polymers as scaffolds for guided cellular in-growth, cell transplantation, or the delivery of therapeutic molecules as methods for regenerating orthopedic tissue.

The biodegradable polymer poly(propylene fumarate) (PPF) has been extensively studied as a scaffold for guided bone regeneration. To create a bone-inducing (osteoinductive) material, poly(DL-lactic-*co*-glycolic) acid (PLGA) microparticles were incorporated into PPF scaffolds, creating a composite that can act as a controlled release vehicle as well as a scaffold for tissue in-growth. Initial *in vitro* studies were conducted to assess the main factors influencing the release kinetics of entrapped peptides and proteins. Results indicate that release from these composite materials is regulated by properties of the microparticles such as initial drug loading and properties of the composite material such as microparticle loading and initial leachable porogen content of the composite material. *In vitro* degradation studies demonstrate that microparticle loading within the PPF/PLGA composite scaffolds as well as initial porogen content of the composite scaffolds influence the initial mass, porosity, and mechanical properties, but does not impact the overall rate of degradation. Finally, PPF/PLGA composite scaffolds with varying release rates of an osteoinductive peptide were implanted *in vivo* to determine the effects of varied release kinetics on bone formation. After 12 weeks, tissue response was assessed using radiography, micro-computed tomography, and histology. Results show that a large initial burst release results in greater bone formation than an extended release of the same dose of peptide. Our work demonstrates the utility of composite materials, PPF/PLGA particularly, for the stabilization of large defects as well as the controlled release of bioactive molecules for the regeneration of natural tissue.