Mechanical Property and Biocompatibility of PLLA Coated DCPD Composite Scaffolds

Nida Tanataweethum[1], Wai Ching Liu[2], Tien-Min G. Chu[2]
[1]Department of Biomedical Engineering, Purdue School of Engineering and Technology; [2] Department of Restorative Dentistry, Indiana University School of Dentistry.

Introductions: Dicalcium phosphate dehydrate (DCPD) cements have been used for bone repair due to its excellent biocompatibility and resorability. However, DCPD cements are typically weak and brittleness. To address these limitations, the addition of sodium citrate as a regulator and polylactic acid (PLLA) as reinforcing agent has been proposed in this study.
Objectives: 1) To develop composite PLLA/ DCPD scaffolds with enchanted toughness by PLLA coating. 2) To examine cell proliferation on the scaffolds. 3) To investigate the degradation behaviors of DCPD and PLLA/DCPD scaffolds.
Materials and Methods: DCPD cements were synthesized with a 1:1 ratio of monocalcium phosphate monohydrate and β-tricalcium phosphate with and without 100 mM sodium citrate in the mixing liquid. The specimens were prepared with powder to liquid ratio (P/L) of 1.00, 1.25 and 1.50. To fabricate the PLLA/DCPD composite scaffolds, DCPD scaffolds were coated with 5 % PLLA. The chemical and mechanical properties of DCPD scaffolds with and without PLLA coating after the in-vitro degradation (day 1, week 1, 4, and 6) were investigated by measuring their porosity, diametral tensile strength, and energy to fracture. In addition, cell adhesion and proliferation on these scaffolds were examined by scanning electron microscopy.
Results: the addition of sodium citrate and the infiltration of PLLA significantly increased the mechanical properties of DCPD scaffolds ($p < 0.05$). The range of diametral tensile strength was 0.50-2.70 MPa and the range of energy to fracture was 0.80 to 9.90 N-mm. The most effective improvement of tensile strength and energy to fracture was achieved with P/L of 1.50. Moreover, incorporating PLLA to DCPD scaffolds slowed down the weight loss in the vitro degradation.
Conclusion: a combination of template-casting and polymer impregnation methods can be applied to fabricate a cement/polymer biodegradable scaffold for bone tissue regeneration with significantly slow down degradation and excellent biocompatibility.

Mentor: Tien-Min G. Chu, Department of Restorative Dentistry, Indiana University School of Dentistry, IUPUI