Comparative Properties of Gelatin/Synthetic Bone Mineral Composite and Bovine Bone

Racquel Z. LeGeros, Prachi Khanna, Shweta Saraswat, Dindo Mijares, Jason Dai
New York University College of Dentistry

Statement of Purpose: Synthetic bone mineral (SBM) preparations were shown to minimize bone loss induced by estrogen deficiency in a rat model [1, 2]. The SBM consists of carbonate apatite incorporating magnesium, zinc with and without fluoride ions. These ions have been associated with biomineralization. Bone is a biocomposite consisting of a biopolymer (mostly collagen) and biomineral (carbonate apatite). The purpose of the study was to prepare gelatin/SBM composite and compare their properties to those of bovine bone.

Methods: The SBM was prepared by hydrolysis method [3] Gelatin A (Fisher Scientific, New Jersey) was cross-linked using Genipin (WakoPure Chemical Industries, Japan), a natural cross-linking agent with significantly less toxicity than gluteraldehyde [4]. The gelatin/SBM (Gel/SBM, not cross linked; Gel*/SBM, cross-linked) composites were prepared by mixing 35% gelatin and 65% SBM and freeze-drying. The composites were characterized using x-ray diffraction (Philips X'Pert,), FT-IR spectroscopy (Nicolet Magna IR 550 Spectrometer Series II), scanning electron microscopy, SEM (Hitachi S 3500N) and microCT (μCT 40 Scanco Medical, Bassersdorf, Switzerland). Dissolution properties were determined in acidic buffer (0.1M KAc, pH 6, 37^{o}C). Mechanical strength was determined using 3-point bend test with Instron (Series 5560-Table Top Load Frames) at a rate of 10 mm/min. Bovine bone was similarly characterized for comparison. Cell response (differentiation, nodule formation) was evaluated using MC3T3-E1. **Results:** The composition and crystallite size of the SBM were similar to that of the bovine bone mineral. The Gel*/SBM compared to Gel/SBM composites showed lower elastic modulus, flexural strength, dissolution rate, swelling and higher porosity. The Gel*/SBM composites showed several physico-chemical properties similar to that of bone, including: crystal size of the inorganic phase; composition (organic/inorganic ratio); FT-IR spectra; thermal stability; initial dissolution rate and mechanical strength. The differentiation and nodule formation (Fig. 2) were greater on the Gel/SBM composite compared to that on the Gel or on the SBM alone.

Conclusions: Results from this study demonstrated that Gel*/SBM composite have several properties similar to those of bovine bone. Future *in vivo* studies should provide evidence that such synthetic composite may be an alternative to the commercial bovine bone-derived bonegrafts.

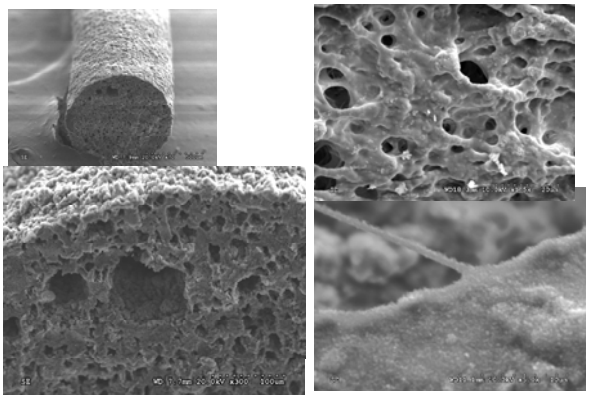

Fig. 1. SEM images of Gel/CHA composite cylinder of different magnifications showing interconnecting porosity and mineralized gelatin fibers.

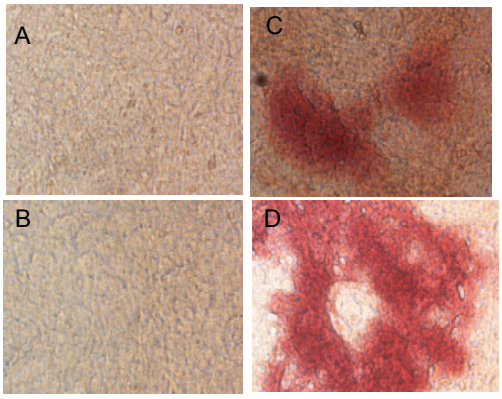

Fig. 2. Calcified nodule formation on (A) control; (B) gelatin; (C) SBM; (D) Gel/SBM after 21 days. (Mag, 40X)

Acknowledgements. This study was supported by research grant no. AR056208 from NIAMS/NIH.

References:

1.Tokudome Y, Otsuka M, Ito A, LeGeros RZ . *J Biomed Mater Res* 2009*;* 90B:2229-237.
2. LeGeros RZ, Mijares D, Yao F, Tannous S, Catig G, Xi Q, Dias R, LeGeros JP. *Key Engineer Mater* 2008; 361-363:43-46.
3. LeGeros RZ. Calcium Phosphates in Oral Biology and Medicine. *Monographs in Oral Sciences Vol. 15.* 1991.
4.Sundararaghavan HG, Monteiro GA, Lapin NA, Chabal YJ, Miksan JR, Shreiber DI. *J Biomed Mater Res A.* 2008 87:308-20.