

OSTEOCONDUCTIVITY OF INJECTABLE COMPOSITES IN RABBITST.Tirri¹, A.J.Aho², J.Rich³, N.Strandberg², J.Seppälä³ & A.Yli-Urpo¹¹ *Biomaterials Research, Institute of Dentistry, University of Turku, Finland*² *Biomaterials Research, Department of Surgery, Turku University Central Hospital, Finland*³ *Laboratory of Polymer Technology, Helsinki University of Technology, Finland*

INTRODUCTION: Thermoplastic composites of bioactive glass S53P4 and Poly(ϵ -caprolactone-co-DL-lactide) were developed as injectable bone filler material. Composites with different amount and different area/volume ratio of bioactive glass (BAG) were earlier characterized *in vitro*¹. Aim of this study was to evaluate composites with different amount of BAG for their osteoconductive properties and overall biocompatibility in bone.

METHODS: Bioactive glass S53P4 (Abmin Technologies, Finland), granule size 90-315 μm , was blended in P(CL/DL-LA) matrix as described by Rich et al.¹. Wt-% composition of the glass is 53.0 SiO₂, 23.0 Na₂O, 20.0 CaO, 4.0 P₂O₅. Three composites and neat copolymer as control were used in the study (Table 1). Sucrose as *in situ* porosity creating agent was blended to one composite to enhance bone ingrowth. Initial compressive strength of the composites was determined using PC programmed testing machine. The study was approved by the Ethical Committee for the Animal Experiments at the University of Turku and it was carried out according to national guidelines for laboratory animal care. Operations were performed under general anesthesia and aseptic surgical standards were followed. Trephine bur was used to drill a round defect (depth 5 mm, diameter 6 mm) in the medial condyle of the distal femurs of 12 female NZW rabbits. Materials were heated and injected to fill the bone defect (n=24). At 4 and 8 weeks 6 animals were killed, specimens obtained, fixed and dehydrated in ethanol and embedded in resin. Cut&grind –method was used to produce thin sections for light microscopy. Van Gieson's and Masson-Goldberg trichrome stains were used. Direct bone contact at the biomaterial-tissue interface was measured from the sections with computerized histometric analysis system.

Table 1. Composites of bioactive glass S53P4 (BAG) and P(CL/DL-LA) used in the study.

	C40	C50S	C60	C0
Wt-% of BAG	40	50	60	-
Wt-% of sucrose	-	20	-	-

RESULTS: Composites had good handling properties and adjusted well to the cavitory bone defect. They were injectable at 47-50°C and hardened within 30 seconds. Initial compression strength of the composites C60 and C50S was 7(\pm 1) MPa. All materials had low foreign body cell reaction and they were considered biocompatible in bone.

Results of the histometric analysis are shown in Fig.1. New bone formation occurred on all composite specimens whereas copolymer without BAG was always surrounded by thin and dense fibrous tissue capsule. Both ongrowth and ingrowth of bone was regulated by the amount of glass granules in the composite. C40 had only few glass granules in contact with host tissue and showed almost no bone ingrowth as well as poor bone contact. Composites C50S and C60 showed good integration into trabecular bone and especially C60 conducted bone growth along the composite surface. Bone ingrowth occurred around the glass granules in outermost part of the composites. Addition of sucrose did not result in significantly higher bone ingrowth.

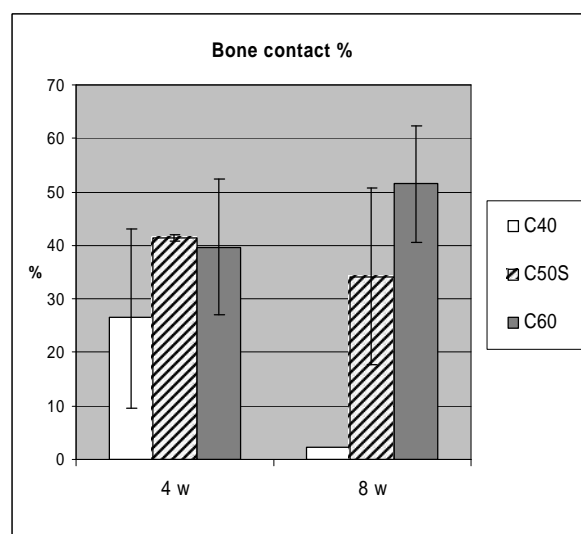


Fig.1. Direct bone contact % (average, SD) at the composite-tissue interface at 4 and 8 weeks measured as percentage of the whole interface.

DISCUSSION & CONCLUSIONS: Injectable composites of bioactive glass S53P4 and P(CL/DL-LA) were biocompatible and integrated into host bone. Resorption of the copolymer *in vivo* seems to be slower than expected and may need to be adjusted for better clinical performance. Growth of bone into the composite occurred via glass granules but ingrowth rate was modest. Addition of sucrose as an *in situ* porosity creating agent did not result in significant increase in bone ingrowth in 8 weeks. Composites with 50 and 60 wt-% of bioactive glass showed good osteoconductivity, had good handling properties and initial mechanical properties corresponding to those of human cancellous bone. In conclusion, they fulfill several properties of ideal injectable bone filler substitute.

REFERENCES: ¹ Rich, J. *et al.* (2002) *Biomaterials*, **23**, 2143-2150.

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