

Osteoblast behaviour on injectable biomaterials intended for augmentation of vertebral compression fractures

[S. Ramstedt](#)¹, [A. Johansson](#)¹, [H. Engqvist](#)², [P. Thomsen](#)¹,

¹[Sahlgrenska Academy, Göteborg University, SWE](#), ²[Angstrom Laboratory, Uppsala University, SWE](#)

INTRODUCTION: Osteoporosis may lead to vertebral compression fractures, caused by low-energy trauma. It has so far been treated by vertebroplasty, which includes injection of cement into the affected vertebrae. The cement hardens in place which results in an immediate reduction of pain and stabilization of the vertebrae. The cement used until now has been different variations of conventional bone cement, PMMA, but more recently new formulations have been evaluated, based upon resin (Bis-GMA) and ceramics (Ca-aluminate). To date, not much information about the cell response to the material has been reported, and more knowledge about the material systems is needed to describe their behavior *in vivo*. In this project the *in vitro* cell response of osteoblast-like cells (MG-63) to these three materials has been investigated.

METHODS: MG-63 cells (3500/well) were cultured on three hardened bone cements; Ca-aluminate cement (CAC, Xeraspine, Doxa), Bis-GMA (Cortoss, Orthovita) and PMMA (Vertebroplastic, DePuy Spine), for 1, 7, 14 and 21 days. Control materials were TCP (Tissue Culture Polystyrene, neg.) and PVC (polyvinyl chloride, pos.). Cell proliferation was measured by the NucleoCounter® system (ChemoMetec A/S, Denmark), cell viability was investigated by LDH-analysis (LDH is an enzyme that leaks out from the cell membrane when the cells undergo necrosis), cell differentiation and mineralization were evaluated by mRNA gene expression of alkaline phosphatase (ALP), osteocalcin (OC) and collagen type I (COLL-I) by qPCR.

RESULTS:

Cell proliferation:

The MG-63 cell number showed an increasing trend by time on all materials. Among the bone cements, CAC was the material where the cells proliferated the most, followed by Bis-GMA and then PMMA. The cell number was highest on TCP and lowest on PVC.

Cell viability:

When comparing the three bone cements, CAC was the one that caused the least leakage of LDH from the cell membrane. All materials showed very high LDH-values at day 1, presumably due to the trypsinization prior the reseeding on to the surfaces.

Cell differentiation and mineralization:

All materials showed an ALP-peak at day 1 (see Fig. 1), followed by decreasing values. CAC provided the strongest ALP-activity, followed by Bis-GMA and then PMMA. The OC mRNA gene expression was similar to the ALP gene expression, while the COLL-I values were highest on TCP, followed by CAC, Bis-GMA and then PMMA.

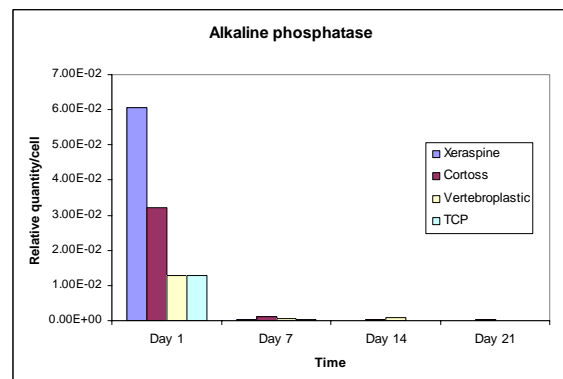


Fig. 1. mRNA gene expression of ALP.

CONCLUSIONS: The cell proliferation and cell viability results both show that, among the bone cements, CAC is the most biocompatible, since the osteoblast-like cells proliferated the most and were most viable on this material. The qPCR-results of ALP, OC and COLL-I, all showed that the cells differentiated and mineralized more strongly on CAC followed by Bis-GMA and then PMMA.

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