Evaluation of *In Vitro* Bioactivity of Different Types of Biomaterials

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INTRODUCTION: Biomaterials are often classified as inert, biodegradable or bioactive materials. For all known bioactive materials an interfacial layer of apatite towards the tissue is formed [1-2]. This finding is used in *in vitro* tests in screening potentially bioactive materials. In this study different types of potentially bioactive materials including a metal, an oxide and some chemically bonded ceramics were evaluated

METHODS: The *in vitro* tests were conducted according to the outline in the ISO-standard ISO/WD 23317. This standard describes a procedure for producing simulated body fluid (SBF), sample preparation, immersion and analysis techniques. For analyses of possible apatite formation scanning electron microscope (SEM), energy dispersive X-ray spectroscopy (EDX) and Xray diffraction (XRD) were used. The samples were also embedded and cross sectioned in attempt to measure the thickness of the layer formed on the sample surface.

MATERIALS: The materials tested were cp Ti, Al_2O_3 and three chemically bonded ceramics, namely a Ca-phosphate, a Ca-aluminate and a Ca-silicate. Ti and Al_2O_3 were also tested after surface activation. The activation of titanium and alumina was done by immersion in 5.0 M NaOH aqueous solution at 60°C for 24 h followed by a gentle washing in distilled water. After the NaOH treatment the samples were annealed at a rate of 5°C/min and kept at 600°C for an hour. The cooling rate was kept at approximately 5°C /min.

RESULTS: The elemental and phase analyses both indicated Ca-phosphate formation on most of the materials tested. The growth rate of the different materials varied. In Fig. 1 the elemental analysis of the layer formed on the Ca-aluminate is presented together with layer of the surface activated titanium. The four largest peaks are O, P, Ca and Al for the Ca-aluminate case and O, P, Ca and Ti for the titanium case. Phase analysis of the layer formed on Ca-silicate showed an amorphous structure.

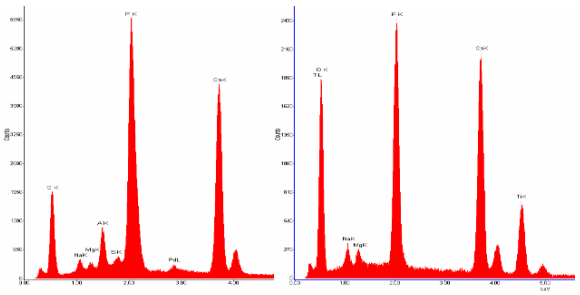

Fig. 1: Elemental composition of layer formed on Ca-aluminate (left) and surface activated Ti (right) in simulated body fluid.

DISCUSSION & CONCLUSIONS: From what can be seen from the experiments and analyses in this study all three bone cements show *in vitro* bioactivity. This indicates these materials as promising candidates for implants intended to bond to bone. However in order to determine true bioactivity *in vivo* tests are necessary. Just as the cements, the activated titanium also shows *in vitro* bioactivity. As was seen the alumina could not be activated to form a hydroxyapatite layer *in vitro* by this method. Li et al, however, claim to have activated alumina by a similar process [3]. The interpretation was done based on a cell culture testing by measuring the difference in adhered cells between treated and non-treated alumina. The results will be discussed in relation to established bioactive materials such as hydroxyapatite and Bioglass®.

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