

Biological responses of human osteoblasts to titanium coated by glow discharge anodisation

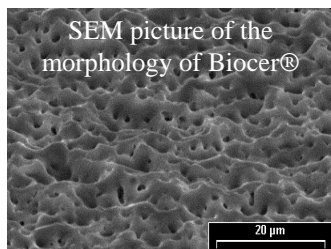
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INTRODUCTION: The use of commercially pure titanium (cp Ti) and titanium alloys in the field of orthopedics and stomatology are widely accepted. Generally, for identification purposes, titanium implants are anodically colored as for instance by the proprietary “Biocoat blue” process. Further improvements in the biological performance can be achieved by surface modifications of these materials. The glow discharge anodisation Biocer® incorporating calcium and phosphate in a porous titanium oxide coating has been investigated.

Thanks to its porous structure this coating is very suitable for a subsequent biofunctionalisation by grafting appropriated molecules.



In this study, we wanted first to compare the biocompatibility of Biocer® and Biocoat blue to cpTi and secondly to investigate the effects of Biocer® grafted with phosphocreatine (PCr). For both sets of experiments, human osteoblasts (HOB) are directly grown on these materials.

METHODS: HOB were isolated from bone chips from patients undergoing hip replacement surgery. In a first set of experiments, HOB were grown in direct contact with cp Ti, Biocer® and Biocoat blue. In a second set of experiments, HOB were grown on Biocer® grafted with PCr, uncoated Biocer® and on Biocer® with 1mM PCr in the growth medium. The standard cell culture polystyrene was used as a control. After 2 weeks, viability (quantification of neutral red uptake), metabolic activity (MTT assay), DNA content as well as bone forming parameters such as alkaline phosphatase activity (ALP) as well as C-terminal propeptide of collagen type I (CICP) and osteocalcin (OC) secretion were quantitatively assessed.

RESULTS: There were no significant differences found for HOB grown on cpTi, Biocer® and Biocoat blue concerning viability, metabolic activity, cellular CICP and OC secretion. This was in contrast to the DNA content and ALP activity, where Biocer® had a significantly higher values

than cpTi (Fig. 1). Concerning ALP activity, Biocer® also was significantly higher than Biocoat blue.

Biocer® grafted with phosphocreatine. There was a significantly higher cellular osteocalcin secretion in the Biocer® groups, even though the number of cells was significantly lower than in the control groups (Fig. 2). All other parameters were similar. Furthermore, Biocer® grafted with PCr as well as Biocer® with 1 mM PCr in the growth medium had a significantly higher metabolic activity than the uncoated Biocer®.

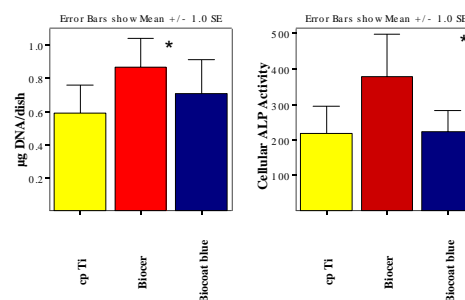


Fig. 1: DNA content (left) and ALP activity (right).

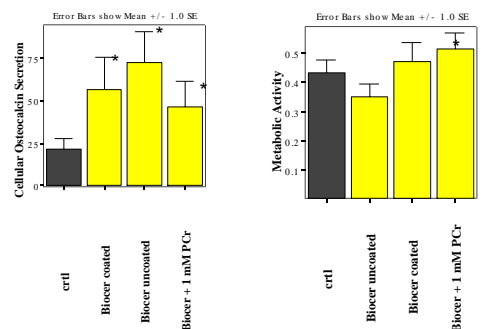


Fig. 2: Cellular OC secretion (left) and metabolic activity (right).

DISCUSSION & CONCLUSIONS: Biocer® and Biocoat blue show similar biological responses as cpTi for viability, metabolic activity, collagen and OC secretion, however Biocer® promotes cell growth and ALP activity over cpTi and even over Biocoat blue for ALP activity. Biocer® promotes differentiation by osteocalcin secretion as compared to the standard polystyrene cell culture dish. In addition, Biocer grafted with PCr significantly stimulates the metabolic activity of HOB.