

# Mechanical properties of injectable calcium phosphate cement incorporated with PLGA microparticles

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## Statement of Purpose:

Autogenous bone grafts are still considered as the golden standard for the filling of bone defects, but their use is limited by the morbidity of the donor site and the small volume available. A solution for these problems could be an injectable calcium phosphate (CaP) cement that can be shaped according to the defect dimension and harden in situ. However, calcium phosphate ceramics are known as slowly biodegradable materials. Therefore, methods have been developed to enhance tissue ingrowth and degradation rate by creating macroporosity of the ceramics. Nonetheless, the creation of porosity is associated with a loss in mechanical strength of the cement material. This appears to make the material less suitable for use under loaded conditions. On the other hand, we believe that the initial decrease in mechanical properties is compensated by the excellent bone biocompatibility of the material, allowing a fast ingrowth of bone into the cement porosity.

In view of the above mentioned and for a safe clinical application of the material, we want to prove that our suggestion is indeed true. Therefore in this study, we will evaluate the mechanical properties of CaP cement discs incorporated with 20% PLGA microparticles which were implanted in cranial defects in male Wistar rats.

## Methods:

CaP cement (Calcibon®, Merck biomaterial GmbH, Darmstadt, Germany) was used for the preparation of the implants. PLGA microparticles were prepared using a (w/o/w) double emulsion solvent evaporation technique. CaP/PLGA composites were prepared by adding PLGA microparticles to the Calcibon powder in a weight ratio of 20% to 80% respectively. Twenty-four male Wistar rats (250g) were used in which a cranial defect was created. The rats were divided in three groups of 8 rats in which each rat received one implant of the same composition. The implantation periods were 2, 4, and 8 weeks respectively.

The specimens were evaluated mechanically (push-out test) and morphologically (Scanning Electron Microscopy (SEM) and histology).

## Results / Discussion:

The results of the push-out test showed that after two weeks the shear strength of the implants was  $0.44 \pm 0.44$  MPa, which increased to  $1.34 \pm 1.05$  MPa at four weeks and finally resulted in  $2.60 \pm 2.78$  MPa at eight weeks. SEM examination showed a fracture plane only at the bone-cement interface at two weeks, while the four and eight week specimens showed a fracture plane which was moved into the CaP/PLGA composites, indicating an increased strength of the bone-cement interface. Histological evaluation showed that the two week implantation period resulted in minimal bone ingrowth, while at four weeks implantation the peripheral PLGA microparticles were degraded and replaced by deposition of newly formed bone. Finally, at eight weeks of implantation the degradation of the PLGA microparticles was almost completed, which was observed by the bone ingrowth throughout the CaP/PLGA composites.

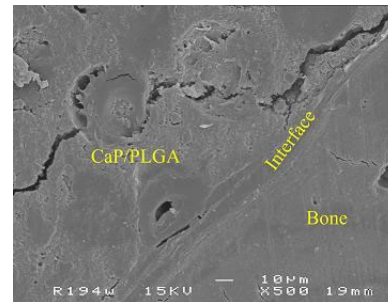


Figure 1: SEM examination of a 4-week implantation period

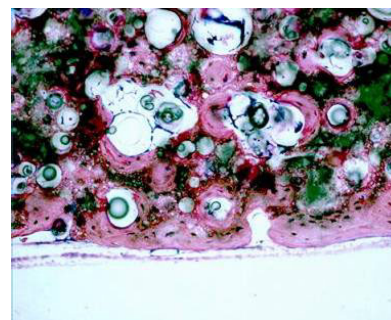


Figure 2: Histology of a 4-week implantation period

## Conclusions:

On basis of our results, we conclude that the shear strength of the bone-cement interface increased during the implantation period due to bone ingrowth into the CaP/PLGA composites, once the PLGA microparticles had been degraded.