Comparison of amorphous TCP nanoparticles to micron-sized α-TCP as starting materials for calcium phosphate cements

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INTRODUCTION: Bone repair and regeneration of defects arising from trauma, tumor or bone diseases display a serious clinical problem in orthopedic surgery. Injectable and resorbable calcium phosphate compounds (CaP) have gained great importance due to their biocompatibility, bioactivity and osteoconductivity and the possibility of minimal invasive surgery. Apatitic calcium phosphate cements (CPC) cure by the reaction of a metastable CaP (e.g. α-TCP). This work describes the use of amorphous TCP, a high-temperature, metastable TCP in the form of nanoparticles for application in apatitic CPCs.

METHODS: The XRD-amorphous TCP (ATCP) nanoparticles were synthesized by flame spray synthesis [1] whereas α-TCP was prepared by solid state chemistry [2]. Reactivity of pure and mixtures of ATCP and α-TCP were tested using isothermal calorimetry. Further analyses included XRD, specific surface area and electron microscopy before and after setting as well as compressive strength and setting time.

RESULTS: Isothermal calorimetry results showed that the ATCP material reacted considerably faster when hydrated with Na_2HPO_4 than the micron-sized α-TCP. The energy release for the ATCP cement was short and intensive (finished after 40 min) whereas the α-TCP reacted for several hours to days. The specific surface area of the set cements, which is very important for the interaction with the implantation site, followed the addition of amorphous material and reached values of up to 160 m^2/g for pure ATCP [3]. The high surface areas are in agreement with the nanostructure of the newly formed apatite crystals shown in Fig. 1.

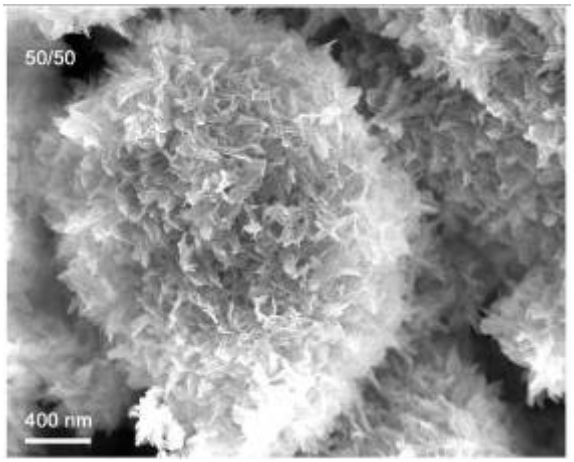

Fig. 1: SEM image of a 50/50 (w/w) mixture of ATCP/α-TCP after setting showing the formation of nanocrystalline apatite.

CONCLUSIONS:
The results clarified the importance of both particle size and phase of TCP on the reaction kinetics of apatitic CPCs. The described aerosol-derived ATCP nanoparticles are an interesting and promising starting material for the use in apatitic cements.

REFERENCES: [1] Loher S, Stark WJ, Maciejewski M et al., *Chem Mater* **2005**;17(1):36-42. [2] Camire CL, Gbureck U, Hirsiger W et al., *Biomaterials* **2005**;26(16):2787-2794. [3] Brunner TJ, Bohner M, Dora C, Gerber C, Stark WJ, *J Biomed Mater Res*, in review.

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