·Assessment of bone ingrowth potential of E-beam produced surface topographies with a biomimetic coating

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INTRODUCTION:
Electron beam melting is a promising technique to produce surface structures for cementless implants. Biomimetic apatite coatings can be used to enhance bone ingrowth. The biomimetic coating process has the possibility to produce a homogeneous coating on complex 3-dimensional structures.The goal of this study was to evaluate bone ingrowth of an E-beam produced structure with biomimetic coating and compare this to an uncoated structure and a conventionally made implant surface.

METHODS:
Implants:
The implants (10x4x4mm) were produced with E-beam technology. (Eurocoating). All E-beam implants had a cubic surface structure (porosity 77%, pore size 1.2 mm). Two structures were coated (Eurocoating), one with hydroxyapatite (cubicHA) and one with brushite (cubicBR). One was left uncoated. A control specimen with a titanium plasma spray coating (TiPS) was also tested. (Figure 1)

Fig. 1: The cubic structure and TiPS

Experimental design:
Surgery was performed on 12 goats. A double set of specimens was implanted in the iliac crest. 4 goats were sacrificed 3 weeks after surgery and 8 goats after 15 weeks. The goats that were sacrificed 15 weeks after surgery received fluorochromes at 5, 10 and 15 weeks. All procedures have been approved by the animal ethics committee of the Radboud University Nijmegen.

Push out test:
The specimens were pushed out the surrounding bone by a Material Testing System (MTS) to define the mechanical strength of the bone-implant interface.

Histology:
Maximum bone ingrowth depth was measured with fluorescence microscopy (5 and 10 weeks) and light microscopy at HE stained slices (15 weeks).

Statistical analysis:
Statistical analyses of the mechanical strength of the bone-implant interface and bone ingrowth depth were performed with a one way ANOVA and a LSD post hoc test.

RESULTS:
The mechanical strength of the bone-implant interface of the cubic structure and the cubicHA were significantly higher compared to the TiPS control at 15 weeks of implantation. (Figure 2)

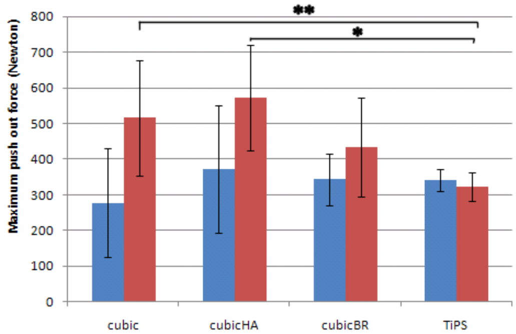

Fig. 2:Mechanical Strength of Bone Ingrowth.
*=3 weeks =15 weeks * p=0.004 **p=0.034*

The maximum bone ingrowth depth of the cubicHA and cubicBR was significantly greater compared to the uncoated cubic structure (at respectively 5&15 and 5,10&15 weeks. Fig 3)

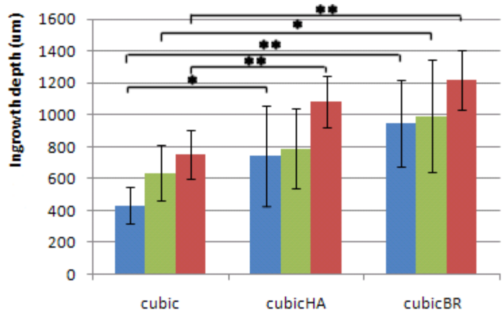

Fig. 3:Maximum Bone Ingrowth Depth
*=5 weeks =10 weeks =15 weeks * p<0.05 **p<0.005*

DISCUSSION & CONCLUSIONS:
The results of this study are promising. Two different CaP coatings were added to E-beam structures to enhance the bone ingrowth potential in an attempt to overcome the disadvantage of the prolonged time in which full bone ingrowth can be reached in highly porous structures. Although no differences between the coated and uncoated cubic structure were found for mechanical push out strength, addition of hydroxyapatite or brushite to the E-beam structure resulted in significantly greater bone ingrowth depth. Thus, addition of biomimetic CaP coatings appears to enhance bone ingrowth. Furthermore, significantly greater ingrowth depth at 5 weeks suggests the acceleration of bone ingrowth by addition of a calcium phosphate coating to the porous E-beam structure.

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