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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 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%). 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).

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.

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).

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)

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. (Figure 3)

DISCUSSION & CONCLUSIONS:

The results of this study are promising. The E-beam structure performed better than a clinically successful coating. Application of a biomimetic CaP based coating on this E-beam surface provided enhanced bone ingrowth. A large surface area associated with a high porosity (as seen in the cubic structure) is known to allow better bone ingrowth. However a setback of a high porosity is that it takes more time before full integration is established. Application of a biomimetic coating appeared to overcome this by providing improved fixation by bone ingrowth in the early postoperative period.

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Figures

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