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Polyhydroxybutyrate for orthopaedic use

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Introduction

A shift in emphasis in biomaterials engineering in recent years has moved the focus of attention from materials that will remain completely stable in the biological environment, to materials that will, in some way, alter their properties or biodegrade. Polyhydroxybutyrate (PHB) is a polyester made by micro-organisms and is fully biodegradable. It has been suggested that PHB composites could be suitable for medical applications since they have the advantages of being biodegradable, biocompatible and have the potential for piezoelectric stimulation of new local bone formation. The modulus of elasticity of injection-moulded composite material was found to fall within the range for human bone from certain anatomical sites. However screws made from PHB-composites are not suitable for orthopaedic use because bone-fixation with screws requires a modulus higher than 25 GPa. So another method for fixation is required.

Objectives

- To develop a new method for biomaterials acting as a scaffold in the fixation of bone fractures.

Material and methods

Material

- PHB was supplied by Zeneka BioProducts.
  Hydroxyapatite was supplied by S.E.C. Italy.

Methods

- Injection moulding
- Tensile testing with extension meter

Results

- The blend with 30 vol% Hydroxyapatite possesses a modulus of 8 GPa. For certain bones that are subject to low load bearing circumstances, as in our purpose, a modulus of 8 GPa can be considered satisfactory.
- Screws designed for fixation bone fractures must have a modulus between 20 and 40 GPa.
- So a new design like two bone plates which are fixed with tie-wraps is proposed.

fig. 1 New design for fixation of fractured bones

- In-vivo tests are still in progress and the results will be submitted soon.

Conclusions

Since our composite material combined with the tie-rap design has so many advantages in contrast to long-term stainless steel implants, it can be concluded that PHB reinforced with hydroxyapatite has considerable potential for use in orthopaedic implants.

References