Large animal in vivo characterization of designated full size magnesium implants by clinical CT in a juvenile sheep model

Summary

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Supervisor:	Prof. Dr. Annelie-Martina Weinberg
Availability:	This position is available.
Offered by:	Medical University of Graz
Application deadline:	Applications are accepted between February 04, 2019 00:00 and March 31, 2019 23:59 (Europe/Zurich)

Description

Background:

In children, surgery has become the state-of-the-art treatment for displaced instable fractures in childhood, thereby reducing hospitalization costs and improving psychological outcomes for children and parents. Typical examples of surgical implants are k-wires or screws in the elbow and elastic stable intramedullary nailing (ESIN) for diaphyseal fractures. Surgical techniques have been adapted to the needs of pediatric fractures to optimally support bone healing (1). Conventional alloying systems including titanium or stainless steel are currently used for osteosynthesis in pediatric orthopedic surgery. In contrast to adults, implants must be removed in children otherwise impeding longitudinal bone growth. Therefore, the need for novel strategies is increasing and resorbable magnesium (Mg)-based implants display a good biocompatibility and mechanical properties. Several studies have demonstrated the osteoinductive properties of Mg implants, which promote callus formation and reduce complications associated with bone fractures. Mg ions released by Mg-based alloys have been demonstrated to influence bone formation, osteoblast proliferation and adhesion (2, 3). In the last decades, biomedical imaging has gained a significant technological push – a development that is of high relevance in practically all fields of medicine. For instance, computed Tomography (CT) or hybrid technologies (e.g. PET-CT, PET-MRI) are the mainstay of diagnosis and therapy monitoring.

Overall aim of the PhD project:

Quantitative and qualitative evaluation of Mg-based implants in juvenile growing sheep

Objectives:

1. Quantitative and qualitative analysis of implantation site with attention to clinically relevant aspects,
2. determination of the suitability of clinically relevant implant shape and Mg amount with respect to local side effects (osteolysis, necrosis, pseudoarthrosis),
3. analysis of degradation behavior (volume and surface changes) and gas evolution in sheep.

Methods:

1. surgical implantation into tibiae of sheep;
2. *in vivo* clinical CT and ex vivo microCT;
3. serum/plasma characteristics;
4. RNA/protein isolation;
5. qRT-PCR;
6. western blot;
7. NMR-based metabolomics phenotyping

Planned and obligatory academic/industrial training:

1. HZG, R. Willumeit-Römer, 1 month, implant alloying and manufacturing, surface observation and characterisation;
2. HiOA, P. Mirtaheri, 2 months, NIRS measurement for application in sheep;
3. Bri.Tech, N. Grün, 1 month, Quality management and certification in industry;
4. CNR-IFC, L. Menichetti, 1 month, large animal PET, µCT, etc.;
5. VSI, J. Jose, 2 months, training in USPA;
6. UiO, H. Haugen, M34, 3 months, sample preparation and establishment in immunohistochemical stainings using ovine bone.

References:

1. A.-M. Weinberg and H. Tscherne, Unfallchirurgie im Kindesalter. Springer Science & Business Media, 2006
2. Cai YL, et al., Osteoblastic cell response on fluoridated hydroxyapatite coatings: the effect of magnesium incorporation. Biomed Mater. 2010;5(5):054114
3. Park J-W, et al., Osteoblast response to magnesium ion-incorporated nanoporous titanium oxide surfaces. Clin Oral Implants Res. 2010;21(11):1278–87

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