Medical University of Graz

Developing a true prognostic in vitro model to elucidate magnesium implant corrosion and its stimulating effect on bone formation

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 10, 2020 00:00 and March 30, 2020 23:59 (Europe/Zurich)

Description

Background:

Conventional permanent metal implants are associated with a notable risk of implant failure, infection, insufficient fracture healing, and chronic inflammation. The beneficial aspects of magnesium (Mg)-based implants include good initial mechanical properties followed by bioresorbability. High concentrations of Mg^{2+} released from Mg-based implants have been shown to promote osteoblastogenesis and to inhibit osteoclastogenesis *in vitro*. Accordingly, Mg-based implants give hope to improve mechanical bone structure during osteosynthesis and bone formation. However, as a first bottleneck in the definition of optimal implants, the underlying molecular interactions and processes at the degrading Mg-based implant surface remain unclear, making the Mg-based implant's structural evolution unpredictable and not yet applicable in clinics. *In vivo* models, are, on the other side, complex black boxes with numerous known but also unknown interfering parameters making the elucidation of degradation mechanisms extremely costly and time-consuming. Accordingly, *in vitro* models exhibit a solution in which specific parameters can be controlled and, as a result, with which the *in vivo* degradation mechanisms and processes can be experimentally characterized and predicted. New predictive *in vitro* models are urgently needed enabling a quantum leap in this area.

Hypothesis and Objectives:

Our hypothesis is that we can develop *in vitro* models which are able to mimic the *in vivo* resorption situation as proven by the formation of similar corrosion product layers (characterized with advanced composition and structural methods). With these *in vitro* models, we will be able to compare and predict how different Mg alloys behave *in vivo*. Moreover, we will be able to elucidate the influence of cells on corrosion mechanism as well as the effects of corrosion products (dissolved ions, solids) on cell phenotype of bone and immune cells.

Methodology:

To test the hypothesis, real- and long-time monitoring of Mg^{2+} release and pH changes will be determined *in vitro* and accordingly, the cell fluid and single cell effects in contact with the Mg implant and Mg^{2+} release will be assessed. These real time recordings will allow to investigate the cell/implant interface and effects on cells (differentiation, proliferation) in an *in vitro* approach validated by *in vivo* experiments and explant surface characterization. To mimic the *in vivo* situation, we will use a novel designed flow chamber at cell culture conditions using a real physiological simulated body fluid (SBF, without non-physiological components like TRIS and HEPES, or high phosphate concentrations), and also combine it with state-of-the-art cellular fluorescence sensors for Mg^{2+} and pH measurements.

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