European Cells and Materials Vol. 5. Suppl. 2, 2003 (page 46) ISSN 1473-2262

ROLE OF THE EXTRACELLULAR MATRIX IN THE BONE-MATERIAL INTERFACE

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INTRODUCTION: The formation of direct bone-material contacts are the generally accepted prerequisite for successful skeletal implants. Maintenance of a material interface to living, properly mineralized bone under functional loading conditions is then called osseointegration. It is the aim of this review to show that not the bone cells, but the extracellular matrix of bone plays the important role in the beginning of bone ongrowth and ingrowth to the different materials surfaces, as well as during the whole lifetime of the respective implants in interaction with material specific degradation and, of course, design specific mechanical load transfer.

METHODS: Interactions of material specific properties and/or degradation with the adjacent bone matrix will be shown from experimental studies of the three major classes of implant materials: corrosion of a metallic material[1], degradation of calcium phosphate ceramics and glasses[2], and certain properties of polymers[3]. After intravital polyfluorochrome labelling, the implants have been embedded with surrounding tissues in polymethylmethacrylate, undecalcified ground sections prepared, surface-stained with Paragon- or Giemsa-solution, and evaluated by transmitted light and fluorescence microscopy. Mineralization was assessed on the same sections from corresponding microradiographs (MR) and back scattered electron (BSE) microscopic images.

RESULTS: Figure 1 shows the tip of a broken dental drill (manganate-steel) 16 weeks after "implantation" in the distal sheep tibia[1]. Deposition of secondary corrosion product iron-oxide caused demineralization of the surrounding bone (arrows) and rust-staining (see Fe-profile).

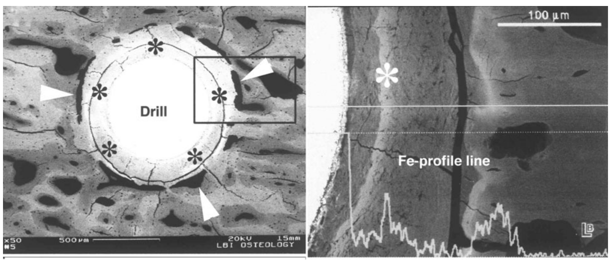
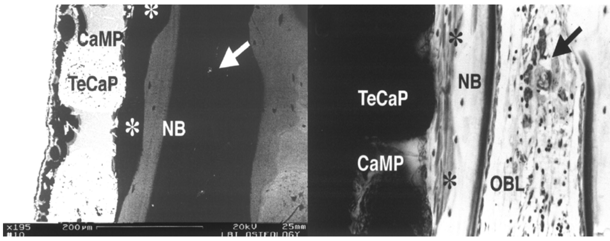
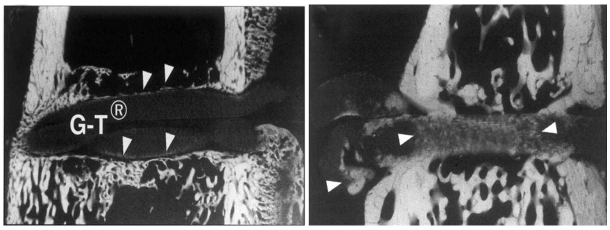


Figure 2 shows the pelvic bone interface of an implant coating (tetracalcium-phosphate granules/ calcium metaphosphate-glass), 16 weeks after implantation[2]. The seemingly void spaces on the BSE-image(*) are composed of demineralized new bone matrix, as can be concluded from the corresponding surface-stained section (right), and from fluorochrome labelling.



In Figure 3, the interfaces of strands of Gore-Tex® in rat tibial bone, 2 weeks (left) and 8 weeks (right) after implantation are shown[3]. Endosteal bone formation had started on mineralized matrix depositions (arrows) within the surface pores of this polymer, and had then virtually impregnated the implant with living bone (arrows).



DISCUSSION & CONCLUSIONS: As pointed out in a recent review[4], in vitro experiments and in vivo observations have shown that not only the "bioactive" ceramics and glasses, but also "bioinert" metal oxides, and even polymers allow for apposition of mineralized bone matrix. In course of time, however, material degradation and ion release may negatively influence mineralization.

REFERENCES: [1]B.Heller et al. (1994) *Z Stomatol* **91** *: 211-18.* [2]J.Gugler et al.(1994) Z *Stomatol* **91***:407-16.* [3] H.Plenk Jr,V.Löhnert, J.Plenk,R.Schabus(1999) *Osteologie* **8**/Suppl.: 78-9. [4]H.Plenk Jr. (2002) Cell and Bone Matrix Interactions at the Implant Interface in *Bridging the Gap between Dental and Orthopaedic Implants* (eds L.P.Garetto, Ch.H.Turner, R.L.Duncan, D.B.Burr) Indiana Univ School of Dentistry, pp 101-111.