

On Possibly Bioactive CP Titanium Implant Surfaces

Akademisk avhandling
som för avläggande av Odontologie Doktorsexamen vid Göteborgs Universitet
kommer att offentligen försvaras i
Föreläsningssal 3, Medicinaregatan 12, 4 tr, Göteborg,
fredagen den 8:e december, kl. 09.00 av

Anna Göransson
Leg Tandläkare



Fakultetsopponent: Professor Birte Melsen, Århus Universitet, Danmark

Avhandlingen baseras på följande delarbeten

I. Göransson A, Wennerberg A.

Bone Formation at Titanium Implants Prepared with Iso- and Anisotropic Surfaces of Similar Roughness: An *in vivo* Study.

Clin Implant Dent Relat Res. 2005; 7(1):17-23

II. Göransson A, Jansson E, Tengvall P, Wennerberg A.

Bone Formation after 4 weeks around Blood-Plasma-modified Titanium Implants with varying Surface Topographies: An *in vivo* Study.

Biomaterials 2003; 24(2):197-205.

III. Göransson A, Gretzer C, Johansson A, Sul Y-T, Wennerberg A.

Inflammatory Response to a Titanium Surface with Potential Bioactive Properties. An *in vitro* Study.

Clin Implant Dent Relat Res. 2006; 8(4):210-217

IV. Göransson A, Gretzer C, Tengvall P, Wennerberg, A

Inflammatory Response to Titanium Surfaces with Fibrinogen and Catalase Coatings. An *in vitro* Study.

J Biomed Mater Res. In press

V. Göransson A, Arvidsson A, Currie F, Franke-Stenport V, Kjellin P, Mustafa K, Sul Y-T Wennerberg A.

An *in vitro* Comparison of Possibly Bioactive Titanium Implant Surfaces.

J Biomed Mater Res. Submitted

Abstract

Background Osseointegrated titanium implants are routinely used in clinical dentistry. Although the overall clinical results are good, there are situations when an improved implant healing is desirable, for instance in compromised bone or in order to decrease healing time. Six factors are proposed to affect titanium implant osseointegration, where one is surface quality. Attempts to optimize surface quality of titanium implants with respect to topography and biochemistry and to prepare possibly bioactive surfaces demonstrate promising results, yet there is a need for further investigations.

Aim The aim of the thesis was to investigate the significance of surface orientation for bone tissue response *in vivo* and, furthermore, to investigate possibly bioactive titanium implant surfaces *in vitro* and *in vivo*.

Material and Methods The thesis is based on five experimental studies, where 12 differently modified CP titanium implant surfaces were investigated.

Topography and chemistry were characterized by Laser Scanning Profilometry, Optical Interferometry, Scanning Electron Microscope and X-ray Photoelectron Spectroscopy, respectively.

In vivo bone responses were evaluated histomorphometrically and mechanically in a rabbit model (Study I, II).

In vitro cell response were investigated in human primary monocyte (Study III, IV) and osteoblast (Study V) cell culture models, while calcium phosphate nucleation (CaP) capacity of the surfaces were investigated in simulated body fluids (SBF) (Study V).

Results In Study I titanium implants prepared with isotropic and anisotropic surfaces with similar roughness demonstrated similar bone response *in vivo* after 3 months of implantation.

In Study II the non-bioactive (anodized) and possibly bioactive (alkali-heat treated) titanium implants with and without covalently immobilized protein coatings (blood plasma) demonstrated similar bone response *in vivo* after 1 month of implantation.

In Study III the non-bioactive (anodized) and possibly bioactive (anodized/Mg) titanium surfaces demonstrated increased inflammatory cell attachment, yet a similar early inflammatory cell response *in vitro* compared to the turned and blasted control surfaces.

In Study IV the protein coatings influenced the early inflammatory response *in vitro*; however, cells on immobilized catalase surfaces, not fibrinogen, demonstrated the strongest inflammatory response.

In Study V the possibly bioactive surfaces (alkali-heat treated, anodized/Mg, fluoride and nano HA coated), gave rise to an earlier CaP formation than the blasted control surfaces. Furthermore, the SBF treated (72 hours) alkali-heat treated fluoride and anodized/Mg surfaces demonstrated similar or decreased bone cell response, while the SBF treated blasted and nano HA surfaces increased bone cell response compared to the blasted controls.

Conclusion Within the limits of the studies of the present thesis, surface orientation had no effect on bone response *in vivo*. Furthermore, possibly bioactive surfaces did not significantly increase bone response *in vivo*, while possibly bioactive/oxide modified and, in particular, bioactive/covalently immobilized proteins influenced early inflammatory cell response *in vitro*.

Key words: titanium implants, surface modification, bioactivity, bone tissue, cell culture

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