SYNTHETIC PHOSPHOSERINE-TETHERED HYPERBRANCHED PEPTIDES AS BIOMIMETIC COATINGS FOR MEDICAL IMPLANTS

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Introduction

In orthopedic as well as in oral and maxillofacial surgery there is an increasing demand for a faster osseointegration of implants. To improve the mechanical anchorage and biological-chemical bond between the implant and the surrounding bone, the state-of-the-art increasingly focus on technological innovation of surface treatments at nano-, micro- and macro-scale. While dental implant design, thread pattern and pitch distances are mechanical implant features related to the macro design, surface nanostructuring and biofunctionalization are approaches aiming to enhance biological reactivity through biomimicking topography and biocue presentation. The present study for the first time analyses the in vivo osseointegrative potential of the phosphoserine-tethered dendron coating applied to dental titanium implants.

Materials and methods

Titanium alloy fixtures (diameter 4.1 mm, length 9 mm) underwent the following surface treatments: (i) a sandblasting and etching (SE); (ii) a macro-porous additive manufacturing (AM) achieved by Direct Metal Laser Sintering (DMLS). The AM implants had a solid core, a macroporous shell 500 µm in thickness, and a solid thread over the porous shell thus limiting the exposed porosity present in between the threads. The interthreads length was 1.5 mm. Porosity was designed according to gyroid geometry thus having a geometrically ordered and repeated unit spatial cell consisting in a knot with three arms departing with 120° of angular distance; (iii) Phosphoserine modified dendron coating prepared as described by Meikle et al. . Altogether four different groups were analysed: Sandblasted and etched implants (SE), porous additive manufactured implants (AM), SE with additional dendron functionalisation (SE-PSD) and AM with additional dendron functionalisation (AM-PSD).

Results and discussion

After 2 and 8 weeks the bone-to-implant contact (BIC) total values of SE implants (43.7±12.2%;53.3±9.0%) and SE-PSD (46.7±4.5%;61.7±4.9%) as well as AM implants (20.49±5.1%;43.9±9.7%) and AM-PSD implants (19.7±3.5%;48.3±15.6%) showed no statistically significant differences. For SE-PSD and AM-PSD a separate analysis of only the cancellous BIC demonstrated a statistically significant difference after 2 weeks and 8 weeks. Biomechanical findings proved the overall trend of an increased stability of the porous implants after 8 weeks.

Conclusions

The functionalisation of the implant surface by phosphoserine-tethered dendron increases trabecular bone formation at the interface of metal implants supporting the role played by the implant topography in osseointegration

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BIOMATERIAL-BASED REGENERATIVE MEDICINE: CHALLENGES & OPPORTUNITIES

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Abstract

For the author there are three major challenges in Regenerative Medicine (RegMed), namely to develop strategies which are translatable, materials which are functional and methods which are predictive. New strategies in RegMed depend on a concerted interdisciplinary effort between the exact and engineering sciences on the one side and the life sciences on the other. As cells synthesize and reside in an extracellular matrix (ECM), which they remodel, a main focus of biomaterial research is the development of injectable, bioresorbable hydrogels containing biological signals which could be released by tissue responses. These interactive materials will certainly increase in importance in the future. However, a major challenge is how to combine them, for example, in composites with load-bearing capacity relevant for human applications. Where synthetic materials such as metals are still essential, as in orthopaedics and traumatology, there is the possibility of adding such responsive materials as coatings to the bulk material. The use of decellularized matrix is also part of the bioinspired approach to developing biomaterials.

In the life sciences great effort is being invested in understanding the so-called „regenerative niche", which differs from tissue to tissue. Great progress made in stem cell biology has opened up new vistas on the possibility to target