Nanostructured biocompatible coatings to prevent implant infections

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Abstract

In this talk, I will review our recent results obtained within the Nanoimplant project, which won in 2014 the IDEA² Madrid Award of the Madrid-MIT M+Vision Consortium, a partnership of the regional government of Madrid and the Massachusetts Institute of Technology (MIT) that fosters innovation in biomedical technologies. The Nanoimplant project is focused on developing a biocompatible and bacteria-inhibiting orthopedic implant using nanostructured coatings (see Fig.), and it is now being funded during one year by the Domingo Martinez Foundation.

Bacterial colonization and biofilm formation on orthopedic implants is one of the worst possible scenarios in orthopedic surgery, in terms of both patient prognosis and healthcare costs [1]. Tailoring the surface of these orthopedic implants to actively promote bone bonding, while avoiding bacterial colonization, represents an interesting challenge to reach better clinical outcomes [2]. Currently, it has been demonstrated a strong dependence of structural features in the nano-scale with antibacterial effects. Several naturally existing surfaces such as plant leaves and insect wings are capable of maintaining a contaminant-free status despite the innate abundance of contaminants in their surrounding environments [3]. These properties are related to the presence of a periodic topography of hexagonal arrays of nanopillar on their surfaces. By mimicking the nature, and to translate this effect to orthopedic metallic biomaterials, a Ti6Al4V alloy of medical grade has been coated with Ti nanostructures employing the glancing angle deposition technique by magnetron sputtering [4,5]. The resulting surfaces have a high density of nanocolumnar structures based on Ti, providing high roughness and a notable decrease of wettability. These nanostructured coatings exhibit a selective behavior towards osteoblast and bacteria proliferation [5]. While these nanotextured surfaces strongly impair bacteria adhesion and inhibit biofilm formation, the osteoblasts exhibit almost identical behavior than that obtained onto the initial Ti6Al4V substrates. This selective behavior is discussed on the basis of a “lotus leaf effect” induced by the nanostructured surface and the different size of osteoblasts and bacteria. The obtained results provide new perspectives for manufacturing metal-based implants to prevent infections.

References

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Figure

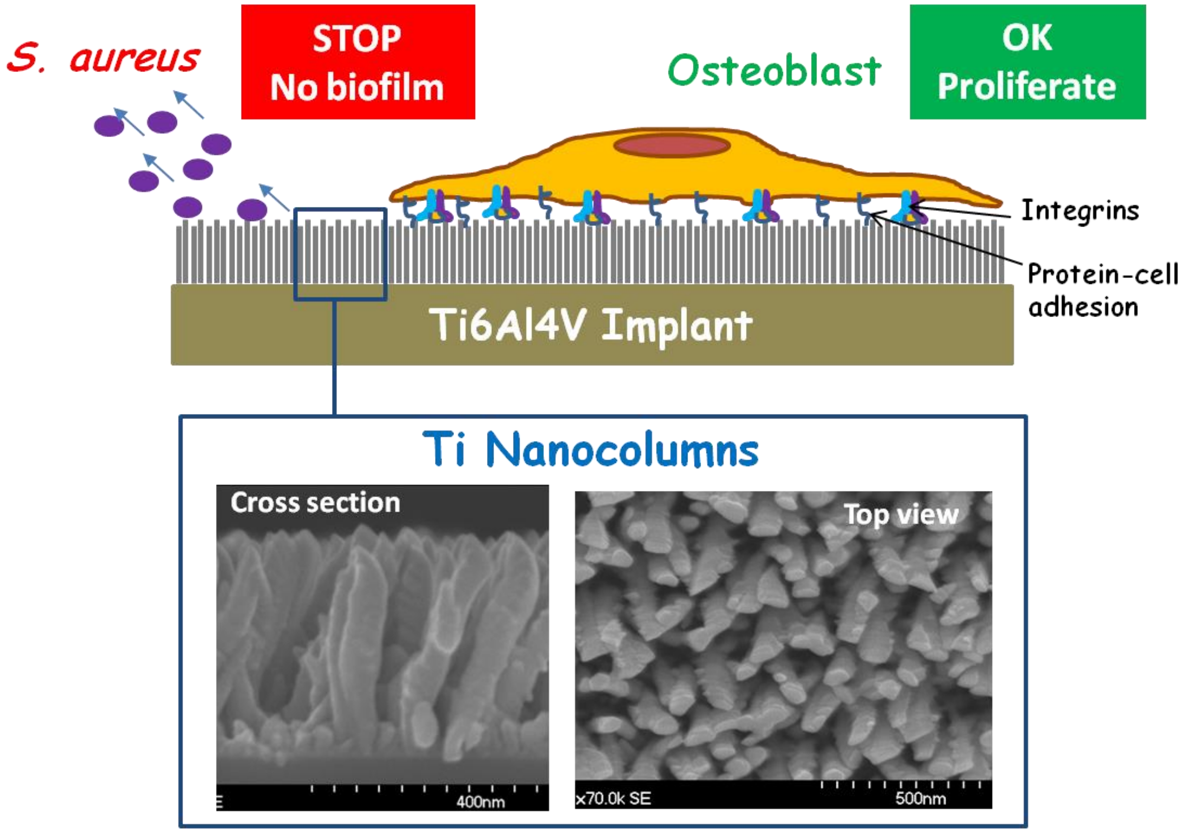

Figure: Summary of the strategy followed in the Nanoimplant project