Implants surface modification: a reliable biomimetic approach

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INTRODUCTION: Dental implants coated with bioactive ceramics are available on the market. Nevertheless, our cost-effective protocol for Ti surface modification aims to accelerate osseointegration and mitigate the temporary weakness in implant stability that occurs a few weeks after implantation. The implant surface is activated with a thin CaP layer using a wet biomimetic route [1].

METHODS: The here developed NanoCoat surface modification is applied to sandblasted and acid-etched surfaces, which are considered as the gold standard in the field. The NanoCoat protocol consists of a multi-step treatment, which generates a thin (~1 µm), chemically bonded nanoporous layer of Ti-based ceramics on the metal surface. Synthetic bone (calcium phosphate) is then grown on the surface in biomimetic conditions, according to an accelerated controlled method [1]. The deposition does not suffer from the line-of-sight issue, as well as does not mask the pristine microroughness.

RESULTS: In-vitro tests were comparatively conducted on ø14 mm Ti discs featuring different surface modification: machined, sandblasted and acid-etched (SLA), surface with grafting layer (GL) obtained by chemical and thermal treatments, and the final NanoCoat surface [1]. Biocompatibility was tested with human osteosarcoma MG63 cells. We investigated cytotoxicity and alkaline phosphatase activity for osteoblast differentiation. On the NanoCoat surface, MG63 cells proliferated at the same rate as on control (SLA) titanium surfaces and exhibited a healthy, spread morphology (Fig. 1). The alkaline phosphate activity (ALP) after two weeks, as an indicator of osteoblastic (bone-like) differentiation calibrated to protein content, was evaluated as well. The results demonstrate differences among the four surfaces (Fig. 2), whereby the NanoCoat surface features an osteoblastic differentiation with ALP activities twice as high as the gold-standard benchmark (i.e., SLA).

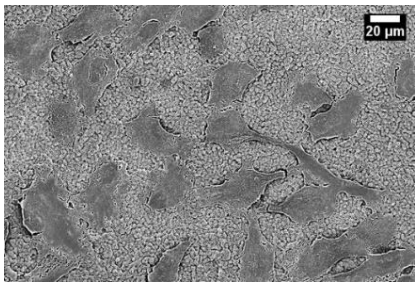

Fig. 1: MG63 cell spreading and proliferation on a substrate with NanoCoat surface.

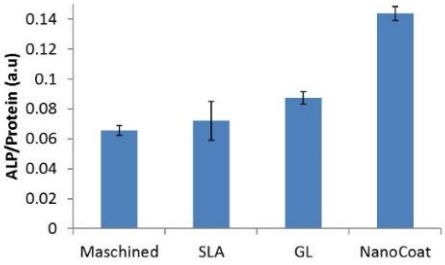

Fig. 2: Comparative ALP assay carried out on four different substrates. The error bars correspond to ±SD.

DISCUSSION & CONCLUSIONS: The experimental results combined with the observed process stability show the ability of the NanoCoat technology as a potential surface treatment for dental implants. The bioactive surface modification, applied as a showcase on dental screws, can further be used on any Ti-based permanent implant, such as craniomaxillofacial, spinal, and orthopaedic implants.

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REFERENCES: [1]A. Carino, *et al.* (2018) *Formation and transformation of calcium phosphate phases under biologically relevant conditions: Experiments and modelling*, Acta Biomaterialia **74**: 478.