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One dimensional nano-titanate on titanium: regulation of mesenchymal stem cells fate

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Introduction: Medical artificial bone materials have always been applied in orthopedics and dentistry, especially titanium substitutes are used worldwide for its unique characteristics in mechanics such as lower modulus and intensive corrosion resistant, superior biocompatibility. [1] Controlling the differentiation of mesenchymal stem cells into a desired specific cell lineage on the material surface is a key factor for the success of implants. [2] Meanwhile, biophysical cues and methods can regulate the fate of mesenchymal stem cells. [3] Here we designed a material which had one dimensional nano-titanate on titanium to regulate the fate of mesenchymal stem cells. We obtained micro-nano scale surface via combined selective laser melting (SLM) and alkali treatment titanium substrates.  

Materials and Methods: In order to estimate the phase structure about the obtained one dimensional nano-titanate on titanium, the commercial available pure Ti(Cp Ti) treated by different concentrations of KOH solutions were analyzed by X-ray diffraction (XRD, D8A25, Bruker, Germany) in continuous mode, scanning 2θ from 20° to 70° with a step size of 0.02° and the incident beam of 3°. The morphology and composition of the titanium were further observed by a scanning electron microscopy (SEM, JSM7100F and JSM6510LV) equipped with energy-dispersive spectroscopy (EDS). The microstructure of the one dimensional nano-titanate was investigated using a transmission electron microscope (TEM, Tecnai G20) and selected area electron diffraction (SAED). In vitro responses of mesenchymal stem cells was evaluated by MTT, ALP, Quantitative PCR (q-PCR), Alizarin Red S Staining, Immunofluorescence Staining in rats.  

Results and Discussion: The results demonstrated that Cp Ti treated in KOH solution with different concentration exhibited highly squid-like structures (Figure 1). Micro-nano scale surface had great influence to MSCs.  

Conclusion: In conclusion, we have demonstrated that MSCs on Ti with one dimensional nano-titanate but with different surface topographies had different adhesion, morphology, proliferation and differentiation behaviors. MSCs adhered more tightly to the Ti with one dimensional nano-titanate compared to Cp Ti. Meanwhile, Ti with one dimensional nano-titanate promoted the osteogenic differentiation of MSCs.
Figure 1 Synthesis and characterization of Ti with one dimensional nano-titanate. a) Synthetic procedure. b) SEM image (one dimensional nano-titanate on titanium). c) XRD analysis. d) MTT

References:

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