OFFICIAL ABSTRACT and CERTIFICATION

Investigating Substrate Mechanics Effects in Combination with TiO2 Thin Layer Coated by Atomic Layer Deposition (ALD) for Dental Pulp Stem Cell Proliferation and Differentiation

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We introduce a new method to deposit a thin layer of titanium dioxide by Atomic Layer Deposition (ALD) on PB substrates to investigate DPSC behavior and differentiation in an environment where surface chemistry has changed but substrate modulus remains the same. ALD was employed to deposit TiO2 on thin (20 nm) and thick (200 nm) PB substrates, which respectively formed hard and soft substrate mechanics effects. All substrates were cultured with human DPSC, with data samples taken weekly. At first week, population doubling time determined that ALD had no major effect on cell proliferation while confocal images showed similar actin stretching of DPSC on all hard and soft PB substrates, suggesting that the TiO2 nanolayer has minimal effect on cell behaviors in the initial period. At the later stage of differentiation, biomineralization was characterized by SEM/EDS, with templated, mineralized deposits observed only on ALD coated both hard and soft PB substrates. Osteocalcin (OCN) antibody staining observed by confocal also showed that ALD coating substrates favored OCN protein, suggesting that TiO2 ALD coating promotes differentiation and biomineralization on soft PB substrates where no mineralized deposits and upregulation of OCN was found. On the other hand, on hard PB substrates, templated mineralized deposits and more evenly spread OCN protein were observed on ALD coating hard substrates, suggesting that surface chemistry of TiO2 coating by ALD may alter DPSC behaviors and differentiation pathway. This ALD method provides a potential application to coat a nanolayer of titanium on any biomaterial to further promote stem cells differentiation and proliferation.

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