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Letter to Editor Open Access

Stem Cell – Implant Composites for Periodontal Tissue Revival

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Letter to the Editor

Owing to good biocompatibilities, resistance to corrosion and mechanical properties, Titanium (Ti) implants are popularly used in dentistry [1]. The fundamental aspect in the performance of an implant is the mechanical and biological behaviour of its interface with the surrounding micro-environment of the periodontium. A stable, tissue friendly biological and not inert interface between the biomaterial surface and the surrounding tissue is a vital prerequisite both for immediate implant loading and for the long-term success of such implants. The interface is usually achieved by the biological process (partially regulated by mechanical and material properties) known as osseointegration of the implant, which is an intimate connection of the implant within the bone by means of an appropriate and sufficient growth of new bone on the surface of the implant [2]. Achieving a good osseointegration depends on physiological variables of the milieu along with particular properties of the implant material such as biocompatibility of the surface and the surface properties.

There is limited data on the specific cellular and molecular mechanisms involved in the surface chemistry-dependent interactions with mechanical variables of the implants affecting clinical success of dental implantation, despite the widely accepted critical role of the interaction between cells and implant surface in achieving a faster initial bone formation. The use of human mesenchymal stem cells (hMSCs) derived from cross lineage sources in promoting rapid osseointegration of implants has been proven to be highly relevant in terms of their potential to integrate with and promote functional restoration of bone and blood vessels [3]. Due to their strategic location, MSCs have been portrayed as the most important players in bone fracture healing and implantations, better than pre-existing osteoblasts cell population [4]. Implant co-location was shown to induce endogenous MSCs recruitment into the damaged zone as they are responsible cells of the bone healing and bone formation after becoming osteo progenitor cells [5].

With the wealth of information available on dental pulp [6], residing stem cells, methods of harvests, Ti surface physical and surface properties, modifications of surface properties of Ti [7] to mimick the clinical implant surface, we attempted to construct human dental pulp derived mesenchymal stem cells (DPSCs) – Ti biomaterial composite, evaluated the in vitro cellular responses of DPSCs on surface modified titanium discs mimicking the implant material/ surface used in clinics. The purpose of the study was to establish the proof of concept in establishing the compatibility of the cell type and the biomaterial used with the bigger interest to evaluate the therapeutic and regeneration role of the stem cell – implant composite in periodontal tissue repair.

Here, we report that 1×105 cells seeded on 20 and 35mm surface areas of modified Titanium disc surface (Ra=0.32 um; sand blast method) and Coated plastic (control, regular surface for adherent cells), yielded cell proliferation with no contact inhibition observed that was evident with no induced cell death on both the surfaces (Figure 1a). The Cell Adhesion Assay data on modified surface of Ti showed the first maximum adhesion for the surface at 10th hour of incubation while control surface showed adhesion reaching saturation by 3rd hour itself. DPSCs showed <2% fluorescence in the apoptosis assay performed which indicated that surface induced apoptosis was insignificant (Figure 1b).

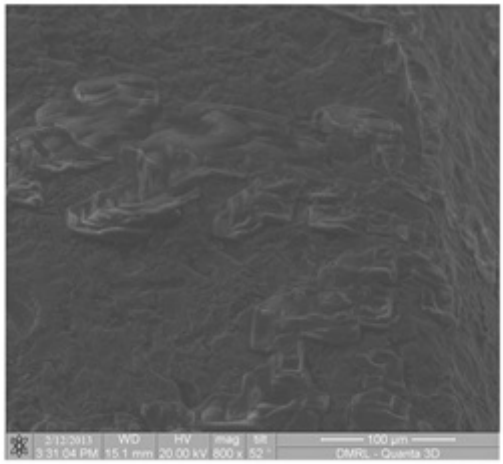

Figure 1a: Scanning Electron Microscopy image of DPSCs adhered to the modified titanium surface

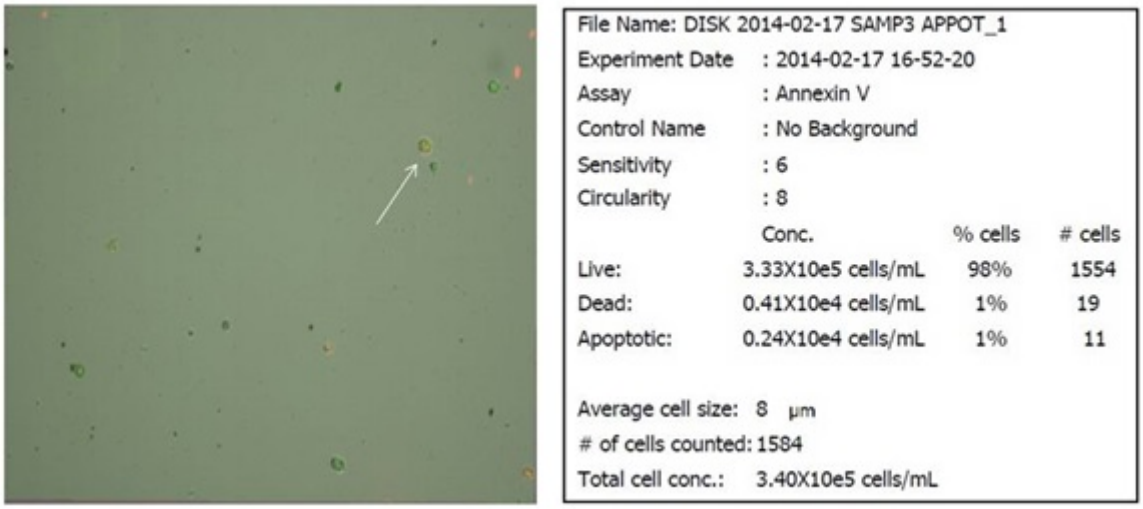

Figure 1b: Tali image based cytometer showing <2% Apoptotic DPSCs cultured on modified titanium surface

Cellular concentrations of 0.5×105 cells, 1×105 cells and 2×105 cells per surface were used to assess the proliferation rate. Although an increase in cell proliferation between 15th and 20th days of culture period was observed on both the surfaces (modified Ti surface and control plastic surface), the population doubling time lag was observed specific to the surface in discussion. Though Ti surface supported the cell proliferation, the data captured on the percentage of growth (cell count on 20th day of culture period/seeding density×100) with all the three different seeding densities was an average of 3.2 times only while it was 21.3 times on control plastic surface. Here, from our data, we speculate that the Ti surface to be only cell friendly but not aiding in cell growth in comparison to the coated plastic surface though some authors [2] advocated that implant surface roughness, achieved by specific texturization techniques, favor cell responses. Additionally, we argue that cell differentiation is a key property of stem cell population that could be studied and evaluated in the cultured stem cell-Ti composite with regards to bone integration or ectodermal lineage differentiation studies though the cell proliferation is not an event that we documented. We want to emphasize on our observation as the Ti surface not supporting stem cell proliferation is not dismissing the biomaterial use in Implantology and tissue engineering. The data only indicates that the cell density be appropriately adjusted for seeding experiments to make progress in evaluating the stem cell – Implant composite's Osteogenic and any nerve re-conduction properties.

In summary, our in-vitro cellular kinetics results suggest that DPSCs and modified Ti surface are friendly with each other with no surface induced apoptosis documented. This responsive composite prepares to consider effects of surface cultured DPSCs on osteo and nerve re-conduction in micro environment in periodontal tissue regeneration.

Acknowledgements

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