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The Effect of Calcium Phosphate Composite Scaffolds on the Osteogenic Differentiation of Rabbit Dental Pulp Stem Cells

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Abstract : The objective of this study was to compare the effects of the two calcium phosphate composite scaffolds on the attachment, proliferation and osteogenic differentiation of rabbit dental pulp stem cells (DPSCs). One nano-hydroxyapatite/collagen/poly (L-lactide) (nHAC/PLA), imitating the composition and the micro-structure characteristics of the natural bone, was made by Beijing Allgens Medical Science & Technology Co., Ltd. (China). The other beta-tricalcium phosphate (β-TCP), being fully interoperability globular pore structure, was provided by Shanghai Bio-lu Biomaterials Co, Ltd. (China). We compared the absorption water rate and the protein adsorption rate of two scaffolds and the characterization of DPSCs cultured on the culture plate and both scaffolds under osteogenic differentiation media (ODM) treatment. The constructs were then implanted subcutaneously into the back of severe combined immunodeficient (SCID) mice for 8 and 12 weeks to compare their bone formation capacity. The results showed that the ODM-treated DPSCs expressed osteocalcin (OCN), bone sialoprotein (BSP), type I collagen (COLI) and osteopontin (OPN) by immunofluorescence staining. Positive alkaline phosphatase (ALP) staining, calcium deposition and calcium nodules were also observed on the ODM-treated DPSCs. The nHAC/PLA had significantly higher absorption water rate and protein adsorption rate than ß-TCP. The initial attachment of DPSCs seeded onto nHAC/PLA was significantly higher than that onto ß-TCP; and the proliferation rate of the cells was significantly higher than that of ß-TCP on 1, 3 and 7 days of cell culture. DPSCs+ß-TCP had significantly higher ALP activity, calcium/phosphorus content and mineral formation than DPSCs+nHAC/PLA. When implanted into the back of SCID mice, nHAC/PLA alone had no new bone formation, newly formed mature bone and osteoid were only observed in β-TCP alone, DPSCs+nHAC/PLA and DPSCs+β-TCP, and this three groups displayed increased bone formation over the 12-week period. The percentage of total bone formation area had no difference between DPSCs+β-TCP and DPSCs+nHAC/PLA at each time point□but the percentage of mature bone formation area of DPSCs+β-TCP was significantly higher than that of DPSCs+nHAC/PLA. Our results demonstrated that the DPSCs on nHAC/PLA had a better proliferation and that the DPSCs on β-TCP had a more mineralization in vitro, much more newly formed mature bones in vivo were presented in DPSCs+β-TCP group. These findings have provided a further knowledge that scaffold architecture has a different influence on the attachment, proliferation and differentiation of cells. This study may provide insight into the clinical periodontal bone tissue repair with DPSCs+β-TCP construct.

Keywords : dental pulp stem cells, nano-hydroxyapatite/collagen/poly(L-lactide), beta-tricalcium phosphate, periodontal tissue engineering, bone regeneration
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