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Reconstruction of Alveolar Bone Defects Using Bone Morphogenetic Protein 2 Mediated Rabbit Dental Pulp Stem Cells Seeded on Nano-Hydroxyapatite/Collagen/Poly(L-Lactide)

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Abstract : Objective: The objective of the present study is to evaluate the capacity of a tissue-engineered bone complex of recombinant human bone morphogenetic protein 2 (rhBMP-2) mediated dental pulp stem cells (DPSCs) and nano-hydroxyapatite/collagen/poly(L-lactide)(nHAC/PLA) to reconstruct critical-size alveolar bone defects in New Zealand rabbit. Methods: Autologous DPSCs were isolated from rabbit dental pulp tissue and expanded ex vivo to enrich DPSCs numbers, and then their attachment and differentiation capability were evaluated when cultured on the culture plate or nHAC/PLA. The alveolar bone defects were treated with nHAC/PLA, nHAC/PLA+rhBMP-2, nHAC/PLA+DPSCs, nHAC/PLA+DPSCs+rhBMP-2, and autogenous bone (AB) obtained from iliac bone or were left untreated as a control. X-ray and a polychrome sequential fluorescent labeling were performed post-operatively and the animals were sacrificed 12 weeks after operation for histological observation and histomorphometric analysis. Results: Our results showed that DPSCs expressed STRO-1 and vementin, and favoured osteogenesis and adipogenesis in conditioned media. DPSCs attached and spread well, and retained their osteogenic phenotypes on nHAC/PLA. The rhBMP-2 could significantly increase protein content, alkaline phosphatase (ALP) activity/protein, osteocalcin (OCN) content, and mineral formation of DPSCs cultured on nHAC/PLA. The X-ray graph, the fluorescent, histological observation and histomorphometric analysis showed that the nHAC/PLA+DPSCs+rhBMP-2 tissue-engineered bone complex had an earlier mineralization and more bone formation inside the scaffold than nHAC/PLA, nHAC/PLA+rhBMP-2 and nHAC/PLA+DPSCs, or even autologous bone. Implanted DPSCs contribution to new bone were detected through transfected eGFP genes. Conclutions: Our findings indicated that stem cells existed in adult rabbit dental pulp tissue. The rhBMP-2 promoted osteogenic capability of DPSCs as a potential cell source for periodontal bone regeneration. The nHAC/PLA could serve as a good scaffold for autologous DPSCs seeding, proliferation and differentiation. The tissue-engineered bone complex with nHAC/PLA, rhBMP-2, and autologous DPSCs might be a better alternative to autologous bone for the clinical reconstruction of periodontal bone defects.

Keywords : nano-hydroxyapatite/collagen/poly (L-lactide), dental pulp stem cell, recombinant human bone morphogenetic protein, bone tissue engineering, alveolar bone
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