Biomimetic Calcium Silicate Support Differentiation of Human Orofacial Bone Marrow Stromal Cells

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Human orofacial bone marrow stromal cells (OFMSCs) from maxilla and mandible have robust osteogenic regenerative properties that demonstrate phenotypic and functional differences between jaw and axial bone marrow stromal cells in same individuals. A combination of OFMSCs with bioactive calcium-releasing scaffolds can potentially improve OFMSC multi-lineage differentiation abilities, but biocompatibility of calcium silicate cements with OFMSCs is still unclear. We tested the hypothesis that material extracts of calcium-releasing calcium-silicate scaffolds support biomimetic microenvironment for survival and differentiation of human OFMSCs. Two experimental calcium-silicate cements were formulated 1) calcium-silicate mineral powder (wTC) containing di- and tricalcium-silicate, calcium sulphate, and calcium chloride and 2) wTC doped with alpha-tricalcium phosphate (wTC-αTCP). Cement setting times were assessed by Gilmore needles, ability to release calcium and hydroxyl ion was assessed by potentiometric methods and OFMSC attachment to calcium-silicate discs was assessed relative to tissue culture plastic. Calcium-silicate material extracts were tested for ability to support OFMSCs survival and in vitro/in vivo differentiation. Fewer OFMSCs attached to calcium-silicate discs relative to tissue culture plastic ($p=0.001$). Extracts of calcium-silicate cements sustained OFMSC survival, maintained steady state levels of vascular cell adhesion molecule-1, alkaline phosphatase and bone sialoprotein while upregulating their respective gene transcripts. Adipogenic and in vivo bone regenerative capacities of OFMSCs were also unaffected by calcium-silicate extracts. Ion-releasing calcium-silicate cements support a biomimetic microenvironment conducive to survival and differentiation of OFMSCs. Combination of OFMSCs and calcium-silicate scaffolds represents candidate graft material for bone regeneration.