Enzymatic, urease-mediated mineralization of gellan gum hydrogel with calcium carbonate, magnesium-enriched calcium carbonate and magnesium carbonate for bone regeneration applications - DTU Orbit (15/12/2018)

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Mineralization of hydrogel biomaterials is considered desirable to improve their suitability as materials for bone regeneration. Calcium carbonate (CaCO₃) has been successfully applied as a bone regeneration material, but hydrogel-CaCO₃ composites have received less attention. Magnesium (Mg) has been used as a component of calcium phosphate biomaterials to stimulate bone-forming cell adhesion and proliferation and bone regeneration in vivo, but its effect as a component of carbonate-based biomaterials remains uninvestigated. In the present study, gellan gum (GG) hydrogels were mineralized enzymatically with CaCO₃, Mg-enriched CaCO₃ and magnesium carbonate to generate composite biomaterials for bone regeneration. Hydrogels loaded with the enzyme urease were mineralized by incubation in mineralization media containing urea and different ratios of calcium and magnesium ions. Increasing the magnesium concentration decreased mineral crystallinity. At low magnesium concentrations calcite was formed, while at higher concentrations magnesium calcite was formed. Hydromagnesite (Mg₅(CO₃)₄(OH)₂·4H₂O) formed at high magnesium concentration in the absence of calcium. The amount of mineral formed and compressive strength decreased with increasing magnesium concentration in the mineralization medium. The calcium:magnesium elemental ratio in the mineral formed was higher than in the respective mineralization media. Mineralization of hydrogels with calcite or magnesium calcite promoted adhesion and growth of osteoblast-like cells. Hydrogels mineralized with hydromagnesite displayed higher cytotoxicity. In conclusion, enzymatic mineralization of GG hydrogels with CaCO₃ in the form of calcite successfully reinforced hydrogels and promoted osteoblast-like cell adhesion and growth, but magnesium enrichment had no definitive positive effect. Copyright © 2017 John Wiley & Sons, Ltd.

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