Enhanced spinal cord regeneration by gelatin/alginate hydrogel scaffolds containing human endometrial stem cells and curcumin-loaded PLGA nanoparticles in rat

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Abstract

Spinal cord injury (SCI) is a serious problem with a high prevalence worldwide. The weak capability of the spinal cord for regeneration in association with upregulation of inflammatory factors is two key obstacles against a full SCI repair. Curcumin is a natural substance with anti-inflammatory and neuroprotective effects. Here, we have used a combined strategy using stem cells and hybrid hydrogel scaffolds loaded with curcumin for SCI repair. Curcumin-loaded PLGA nanoparticles were prepared, characterized, and encapsulated into gelatin/alginate hydrogel scaffolds, which were then seeded by human endometrial stem cells (hEnSCs). The resulting construct was studied using in vitro and in vivo experiments on rat models. DLS, SEM, Zeta potential, and FTIR data confirmed the successful addition of curcumin to PLGA nanoparticles. SEM analyses indicated the successful addition of curcumin-loaded nanoparticles into the gelatin/alginate scaffold, as well as the adherence of the seeded EnSCs. Based on the results, the prepared constructs not only allowed the controlled release of curcumin but also could support the survival and growth of hEnSCs. Based on the results of BBB and histological experiments, the highest BBB score was related to the combined strategy, consistent with histological outcomes, in which our hEnSC-seeded gelatin/alginate scaffold containing curcumin-loaded nanoparticles led to improved structures of the white and gray matters in the SCI site, being indicative of the superior nerve fiber regeneration, compared to other studied groups. These results indicate the efficiency of the proposed method for SCI repair and broaden the scope for subsequent studies on spinal cord regeneration.

Keywords: Alginate, Curcumin, Endometrial stem cell, Gelatin, Hydrogel, Spinal cord injury.