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Cold atmospheric plasma modified nanocomposite cartilage scaffold

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ABSTRACT

Articular cartilage connects diarthrodial joints, lubricates surface between bones, transfers and withstands repetitive load over the lifetime, which is prone to degeneration by various diseases, trauma and injuries. Once degeneration takes place, the avascular structure of human cartilage makes the self-healing extremely challenging. Therefore, the main objective of this study is to fabricate a biomimetic nanostructured cartilage scaffold by electrospinning and cold atmospheric plasma (CAP) techniques. Particularly, CAP is an ionized gas with various electrons, positive/negative ions, and excited molecules. It was utilized to create a more biomimetic and biocompatible surface of the electrospun nanocomposite cartilage scaffold. For this purpose, a polycaprolactone scaffold with randomly distributed microfibers was electrospun. Poly(lactic-co-glycolic) acid (PLGA) was employed to fabricate bovine serum albumin (BSA) loaded nanospheres using a water/oil/water double emulsion solvent extraction method and deposited into electrospun fiber mat. The nanocomposite scaffolds were further modified using CAP for 0, 1, 3, and 5 min. Scanning electron microscopy results illustrated the electrospun fibers had uniform diameter distribution and nanospheres were homogenously embedded inside the scaffold. The human bone marrow mesenchymal stem cell (MSC) experiments showed that the cartilage scaffold with BSA loaded PLGA nanospheres can sustainably improve MSC growth after 7 days. Furthermore, CAP modified nanocomposite scaffolds had enhanced cell proliferation after 5 days culture. It is ascribed to both the improvement of hydrophilicity and adhesion-mediating proteins adsorption (vitronectin) on CAP modified scaffolds. The enhanced stem cell response rendered by CAP treatment and nanospheres makes our scaffold promising for improved cartilage regeneration.