ELECTROCONDUCTIVE PHOTO-CURABLE PEGDA-GELATIN/PEDOT:PSS HYDROGELS FOR PROSPECTIVE CARDIAC TISSUE ENGINEERING APPLICATION

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Introduction

Hydrogels are hydrophilic cross-linked polymeric materials that have been widely studied in tissue engineering (TE) to mimic human tissues [1]. The functionality of electroactive tissues, such as cardiac, neural and muscle, strictly depend on electrochemical signaling between cells. Therefore, TE scaffolds interacting with those tissues should be designed with electroconductive properties [2]. Recently, electroconductive hydrogels (ECHs), combining intrinsically conductive materials with hydrogels networks, have demonstrated to be able to promote the formation of electroactive engineered tissues both *in vitro* and *in vivo.*
Poly(3,4-ethylenedioxythiophene):poly(styrene sulfonate) (PEDOT:PSS), a conductive polymer, presents good biocompatibility and dispersibility in aqueous solution. Hence, it has already been involved in the development of ECHs for engineering cardiac or neural tissue [3][4]. Nevertheless, an hydrogel-based scaffold with highly tunable electrical and mechanical properties, showing also bioactivity, biocompatibility and biodegradability, is still missing [2].
The aim of this work, was the development of photo-curable ECHs based on polyethylene glycol diacrylate (PEGDA), gelatin and PEDOT:PSS, with tunable electrical, mechanical and bioactive properties, for cardiac tissue engineering application.

Methodology

In previous studies by the authors, UV-cured hydrogels based on PEGDA and gelatin were obtained [5]. Riboflavin was selected as a biocompatible photoinitiator and three different initial PEGDA/gelatin weight ratios were tested. PEDOT:PSS was incorporated, to impart electrical conductivity to the final system. The photopolymerization process was analyzed through photorheology. Physico-chemical properties of hydrogels were investigated. Mechanical characterization was carried out through compression tests while electrical properties were evaluated by means of sheet resistance and dielectric spectroscopy measurements. *In vitro* degradation properties of hydrogels were also evaluated. Finally, as a proof of concept for cardiac tissue engineering application, *in vitro* biocompatibility and adhesion tests with human cardiac fibroblasts (HCFs) were performed on the developed hydrogels.

Results

The gelation time of hydrogels as well as their final cross-linking density, microstructure, swelling and degradation properties were finely modulated by varying the ratio between PEGDA and gelatin. Accordingly, by increasing PEGDA/gelatin ratio, hydrogels with increasing stiffness were obtained, with elastic moduli similar to those reported for healthy native cardiac tissue. The addition of PEDOT:PSS within the hydrogels reduced their gelation time while increasing both their surface and bulk electrical properties. As a fundamental bioactive component, gelatin was successfully bonded to the final hydrogel network structure. Additionally, hydrogels were cytocompatible and promoted the adhesion of HCFs.

Conclusions

Electroconductive photo-curable PEGDA-gelatin/PEDOT:PSS hydrogels developed in this study are promising candidates for cardiac tissue engineering applications, deserving future investigations.

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