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Studies on Newly Designed Aliphatic Polyesters for Tissue Engineering Materials

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1. Introduction

Recently, much attention has been attracted to tissue engineering technology as new method for regeneration where the tissues have been lost through trauma or disease. As the effective strategy, use of porous scaffold is one of the essential methods for the three-dimensional tissue reconstruction. The requirements of scaffold materials are manifold and extremely challenging. First of all, biocompatibility is imperative, because the material must not elicit an unresolved inflammatory response nor demonstrate immunogenicity or cytotoxicity. Second, the mechanical properties of this material also must be sufficient and not collapse before the regenerated tissue is structurally stabilized. Moreover, degradation profiles are also important since the rate may affect many cellular processes including cell growth, tissue regeneration, and host response. In addition, porosity and pore size of the material should be tunable in order to optimize cell seeding, attachment, growth, extracellular matrix production, vascularization, and tissue ingrowth.

In many cases, the scaffolds for tissue engineering are derived from aliphatic polyesters as poly(glycolic acid) (PGA), poly(ε-caprolactone) (PCL), poly(lactic acid) (PLA) and these copolymers because of good biocompatibility and degradation. Therefore, we studied preparation, as well as physicochemical and biological characterization of CL-LA copolymer-based cross-linked materials.

2. Results and Discussions

The branched CL and LA copolymers, CL-LA 90/10, CL-LA80/20, and CL-LA 70/30 (where CL-LA X/Y denotes the copolymers containing X mol-% of CL and Y mol-% of LA) were synthesized by the ring-opening polymerization of a mixture of CL and LA in bulk. A preliminary experiment suggested that a higher content of the LA composition in the copolymer produced an unsatisfactory mechanical strength due to the lower glass transition temperature. Therefore, the LA content was varied from 10 to 30 mol-%.

Cell adhesion and growth on the prepared cross-linked membranes were evaluated by comparing with the tissue culture polystyrene (TCPS) that is commercially available. The HeLa cells adhered well and extended on the CL-LA70/30c surface, and they were almost comparable to that on the TCPS. We then checked the protein absorption on each surface because the protein adsorption on the material surface is the first event in the contact of cells suspended in a culture medium. It is very interesting to note that CL-LA70/30c is the best in model protein adsorption and better than TCPS with a statistically significant difference. In separate experiments, we succeeded in preparation of flexible scaffold prototype by using branched macromonomer with CL/LA (70/30 mol-%) and salt-leaching method with NaCl particles with different size. Moreover, it is revealed that these materials were a good biocompatibility by cell growth assay.

3. Conclusions

In this study, we could develop the new biodegradable polymeric materials by the copolymerization of CL and LA. The molecular design to obtain the rubbery soft materials was succeeded. It was revealed that it would be suitable for scaffold in practical tissue engineering application.

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