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Surface Characteristics and Fibroblast Adhesion Behavior of RGD-Immobilized Biodegradable PLLA Films

Hyun Jung Jung, Kwang-Duk Ahn, and Dong Keun Han*

Biomaterials Research Center, Korea Institute of Science and Technology, P. O. Box 131, Cheongryang, Seoul 130-650, Korea

Dong-June Ahn

Department of Chemical and Biological Engineering, Korea University, Seoul 136-701, Korea

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Abstract: The interactions between the surface of scaffolds and specific cells play an important role in tissue engineering applications. Some cell adhesive ligand peptides including Arg-Gly-Asp (RGD) have been grafted into polymeric scaffolds to improve specific cell attachment. In order to make cell adhesive scaffolds for tissue regeneration, biodegradable nonporous poly(L-lactic acid) (PLLA) films were prepared by using a solvent casting technique with chloroform. The hydrophobic PLLA films were surface-modified by Argon plasma treatment and *in situ* direct acrylic acid (AA) grafting to get hydrophilic PLLA-*g*-PAA. The obtained carboxylic groups of PLLA-*g*-PAA were coupled with the amine groups of Gly-Arg-Asp-Gly (GRDG, control) and GRGD as a ligand peptide to get PLLA-*g*-GRDG and PLLA-*g*-GRGD, respectively. The surface properties of the modified PLLA films were examined by various surface analyses. The surface structures of the PLLA films were confirmed by ATR-FTIR and ESCA, whereas the immobilized amounts of the ligand peptides were 138-145 pmol/cm^2. The PLLA surfaces were more hydrophilic after AA and/or RGD grafting but their surface morphologies showed still relatively smoothness. Fibroblast adhesion to the PLLA surfaces was improved in the order of PLLA control < PLLA-*g*-PAA=PLLA-*g*-GRDG < PLLA-*g*-GRGD, indicating that PLLA-*g*-GRGD has the highest cell adhesive property.

Keywords: tissue engineering, PLLA film, plasma treatment, direct AA grafting, RGD immobilization, fibroblast adhesion.

Introduction

Tissue engineering which is one of the new fields opened with the development of the science and which is an applied study that utilizes the basic concept and technique of life science and engineering gives a clue to understand co-relationship between a structure and a function of body tissue and make a substitute of the body tissue for transplantation, thereby to maintain, improve or restore the function of human body.[1,2]

One of the typical tissue engineering techniques comprises taking out a required tissue from a patient body, followed by isolating cell from the tissue, proliferating the isolated cell, seeding the cell in the biodegradable porous polymer scaffolds, culturing the cell *in vitro* for a predetermined period, and then, transplanting the obtained hybrid-type cell/polymer structure into the human body. After transplantation is achieved, by virtue of diffusion of body fluids, oxygen and nutrients are provided to transplanted cells in biodegradable porous polymer until a blood vessel is newly formed. When a blood vessel is formed to which blood is supplied, the cells are cultivated and divided to form a new tissue and an organ. During new tissues and organs form, the polymer scaffolds are degraded and disappeared.[3,4]

Among many biodegradable polymers, poly(α-hydroxy acids) such as poly(glycolic acid) (PGA) and poly(L-lactic acid) (PLLA) have attained a unique position in the field of biomedical materials because of their excellent mechanical properties and biological affinity.[5-7] However, their highly crystalline and hydrophobic nature has interfered with modulation of their degradation rate and mechanical properties. It has also been difficult to impart functionality to these polymers by application of the ordinary chemical modification methods. Consequently, various attempts have been made to control their physicochemical properties by copolymerization of lactide monomers with other functional monomers, although few works have been successful in proper functionalization so far.[8,9]

*Corresponding Author. E-mail: dkh@kist.re.kr