CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

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Project Number

S0528

Project Title

Effects of Polycaprolactone and UV Treated Poly (methyl methacrylate) Electrospun Fibers on Stem Cell Differentiation

Abstract

Objectives/Goals

The use of polymers to construct 3D biomimetic scaffolds resembling the extracellular matrix (ECM) possesses great potential in tissue engineering. The goal of this study is to engineer 3D electrospun scaffolds of both UV treated Poly (methyl methacrylate) (PMMA) and unmodified Polycaprolactone (PCL) that can successfully induce Dental Pulp Stem Cells to differentiate into the osteogenic lineage to create regenerative bone tissue in vitro.

Methods/Materials

Electrospinning is a process that involves the use of an electrical voltage to generate scaffold fibers on the nanoscale from polymer solutions. Two FDA approved polymers, PMMA and PCL, were used in this study. The effect of fiber diameter was tested by producing 6 um, 1 um, and nanofibers of PMMA. The effect of fiber orientation was tested by producing random oriented fibers and parallel oriented fibers. PMMA fibers were further modified by UV Plasma treatment, in order to increase the surface hydrophilicity of the scaffold.

Results

Confocal microscopy images reveal the success of UV plasma treatment in enhancing the adhesive properties of the PMMA scaffolds, allowing the DPSCs to proliferate along the electrospun fibers. Images of the vinculin stained cells suggest that the interaction between the cell cytoskeleton and the scaffold surface played a pivotal role in morphologically inducing DPSC differentiation in vitro. Atomic Force Microscopy analysis indicates a relationship between cell-cell and cell-surface scaffold hardness. Energy dispersive X-ray analysis, scanning electron microscopy, and mercury lamp images reveal that UV-treated PMMA nanofibers and PCL fibers of random orientation were the most successful scaffolds to induce DPSC differentiation and biomineralization.

Conclusions/Discussion

This study has identified the optimal PMMA and PCL electrospun scaffold characteristics for the morphological induction of DPSC differentiation into osteoblasts without the aid of a chemical inducer. This study also suggests a strong relationship between focal adhesion sites and stem cell differentiation, in addition to establishing UV Plasma treatment as a successful method to induce scaffold hydrophilicity and enhance scaffold adhesiveness. These polymeric scaffolds are the future of tissue engineering.

Summary Statement

The goal of this study is to engineer 3D electrospun scaffolds of both UV treated Poly (methyl methacrylate) (PMMA) and unmodified Polycaprolactone (PCL) that can successfully induce Dental Pulp Stem Cells to differentiate into osteoblasts.

Help Received

This study was conducted at Stony Brook University's Garcia Materials Science and Engineering Center, under the supervision of Dr. Vladimir Jurukovski.