MINI PROJECT - REPORT

Topic: Multilayered Composite Nanofiber Scaffold Embedded with Drug for Controlled Release Specialized for Myocardial Infarction

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Abstract

Building a drug-embedded multilayer composite nanofiber scaffold for myocardial infarction with regulated medication release is the suggestion. In order to prepare the sample for electrospinning, a mixture of PCL, a synthetic polymer, and collagen, a natural polymer, is utilized; this mixture will give the patch mechanical strength. Using porous nanofiber layers, the scaffold acts as a delivery system for drugs, preventing burst release. The layered composite pattern of nanofiber mats further regulates the release.

Introduction

A myocardial infarction is a medical disorder in which blood supply to a portion of the heart is blocked, which results in the death of heart muscle cells. A myocardial infarction (MI), also referred to as a heart attack, is when blood supply to a portion of the heart muscle is suddenly and severely reduced or completely blocked. The rupture of an atherosclerotic plaque, which results in the production of a blood clot and blocks blood flow in the coronary artery, is the usual cause of this blockage. Cardiomyocytes, Endothelial cells, Fibroblasts, Immune cells, and Pericytes are among the cell types impacted by MI. For the treatment and regeneration of myocardial infarction, many types of biomolecules, medications, and cells can be delivered via nanofiber scaffolds (MI). Growth factors, ECM proteins, anti-inflammatory medications, and antithrombotic medications are among the pharmaceuticals that can be given to MI using nanofiber scaffolds.

Objectives

1) Sample preparation for Electrospinning : blend of natural and synthetic polymer
2) Incorporation of drug and required factors
3) Synthesis of composite multi-layered Nanofiber Patch.
4) Determining the controlled drug release
5) Characterization and further analysis to detect efficacy.

Material and Methods

Sample preparation:

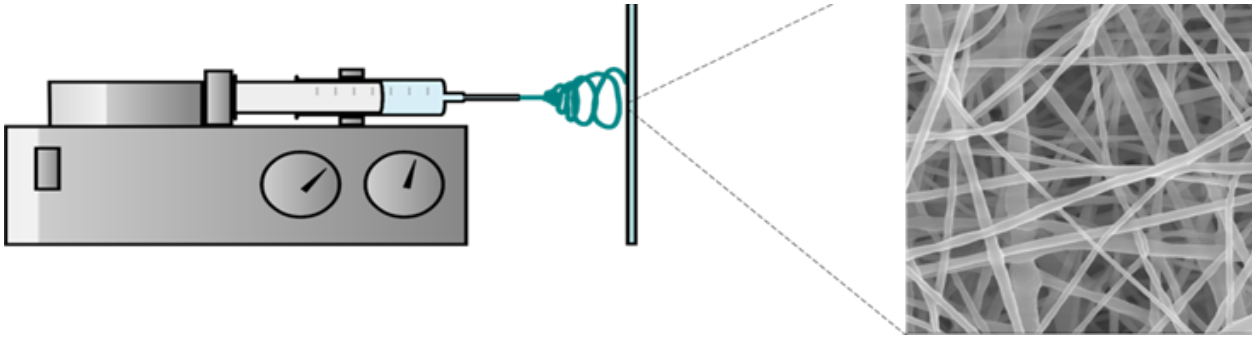
Solubilizing collagen in the chosen solvent followed by blending of PCL into the solution. The homogeneity can be achieved by stirring the solution on a magnetic stirrer and providing appropriate temperature to ease the solubilisation. Keeping the solution for stirring overnight will provide a homogenous and appropriately viscous solution, best suitable for Electrospinning technique.

Drug loading:

Once a homogenous solution is achieved, a therapeutic amount of drug is to be added and allowed to homogenize with the polymeric solution by stirring at room temperature for 1-2 hours or till homogenous.

Electrospinning for Nanofiber synthesis:

Electrospinning is an electrodynamic technique in which liquid drops are charged to create a jet that is then elongated and extended to form fibers. Electrostatic repulsion between the particle surfaces of the same sign distorts the droplet into a Taylor cone, from which an electron-rich jet is ejected.



Composite multilayer formation:

Deposition of layers one above another such that multiple layer composite is formed. The arrangement of layers will be such that the outer first and last layer will be of polymeric blends without any drug and layers in between will be of polymer with loaded drugs.

Analysis and characterization:

Controlled drug release can be determined by taking absorbance per hour through UV-vis-spectrophotometer. The nanofiber patch can be suspended in media containing similar factors as cardiac environment and release of drug can be monitored. Further, testing the nanofiber patch on mouse models for efficacy against myocardial infarction. SEM will determine the morphology of nanofibers, orientation and diameter. FTIR or confocal microscopy will point

out the pattern of encapsulation of drug in nanofiber, because the high voltage in electrospinning sometimes leads of confirmational changes in blended biomolecules.

Result and Discussion:

To address the damage caused by MI, a tissue engineered nanofiber scaffold can be used. A nanofiber scaffold is a 3-Dimensional structure made of biocompatible materials that can provide physical and mechanical support to the damaged tissue. The controlled Electrospinning process is used to make this nanofiber patch. In the context of MI, this nanofiber scaffold can be used to help in regenerating the damaged heart tissue by promoting the growth and differentiation of new cardiomyocytes. To be effective, a nanofiber scaffold needs to have specific properties, such as biocompatibility, mechanical strength, and the ability to support cell growth and differentiation. All these properties are satisfactory in making the nanofiber patch using the above electrospinning method. The reason for using nanofiber patch is due to its controlled procedure, high surface area, its porosity and its scalability.

Conclusion:

The above experiment proposes a solution for treating myocardial infarction (MI) using a drug-embedded multilayer composite nanofiber scaffold that enables controlled drug release. The scaffold is made by blending natural and synthetic polymers, incorporating therapeutic drugs, and using electrospinning to produce a multilayered nanofiber patch. The scaffols's efficiency can be evaluated using methods such as UV-vis-spectrophotometer, SEM, FTIR, and confocal microscopy. The scaffold can potentially regenerate damaged heart tissue by promoting the growth and differentiation of new cardiomyocytes, and has all the necessary properties, such as biocompatibility, mechanical strength, and scalability, for use in treating MI. The proposed solution has significant potential for addressing the damage caused by MI and improving heart function.