The effect of anti-bacterial nanofibrous scaffolds on osteogenic differentiation of human mesenchymal stem cells

Thamonwan Diteepeng¹ Mahsa Mohiti-Asli² and Adisri Charoenpanich¹

¹Department of biology, Faculty of science, Silpakorn University, Nakornpathom, Thailand ²Department of biomedical engineering, North Carolina state university, North Carolina, USA

Email address: dl.thamonwan@gmail.com

Abstract

Silver is a well known antimicrobial material for a wide range of microorganisms. In this study, silver-releasing poly(lactic acid) (PLA) nanofibrous scaffolds were synthesized and evaluated for it biocompatibility with human adipose-derived mesenchymal stem cells (hAMSC). Co-culture of hAMSC with Methicillin-Resistant S. aureus (MRSA) on silver-releasing scaffold was performed to mimic the situation of in vivo bone infection. The results showed that silver-releasing scaffolds were suitable for proliferation and osteogenic differentiation of hAMSC. However, the silver-coated scaffolds did not diminish the growth of MRSA. Further study to improve the anti-microbial properties of the scaffold will progress the scaffold development for bone engineering.

Introduction

Various types of silver have been used as antimicrobial material such as silver nanoparticles, silver ion and silver nitrate. However, overdose of silver can cause adverse effect on human cells. Control-released nanofibrous scaffold, a new approach to release an appropriate concentration of silver, have been developed to exhibit the excellent antimicrobial properties without mammalian cell cytotoxicity.

In this study, silver-releasing nanofibers were synthesized by electrospinning of poly(lactic acid), following with Silvdur ETM coating. Biocompatibility and antimicrobial effect of the scaffold was then evaluated with hAMSC co-culture with MRSA on the scaffold.

Objective

To investigate the effect of silver-releasing nanofibrous scaffold using Silvdur ETM, a silver release coating, on the proliferation and osteogenic differentiation of hAMSC, and on growth inhibition of MRSA.

Methods

This research was supported by the DPST scholarship and department of biology, Silpakorn university. I would like to acknowledge Dr. Adisri Charoenpanich (advisor), Professor Dr. Elizabeth G. Loboa and Dr. Mahsa Mohiti-Asli (co-advisor) for assistance and helpful discussion.

References


Conclusions

Silver-releasing nanofibrous scaffold synthesized in this study was suitable for proliferation and osteogenic differentiation of hAMSC. However, the silver-coated scaffolds did not diminish the growth of MRSA. Therefore, antimicrobial efficacy of silver-releasing nanofibrous scaffolds should be developed to inhibit the growth of bacteria before any further study.

Results

1. Characterization of silver-releasing PLA nanofibers

Fig. 1. Silver-releasing nanofibers with the naked eyes (a) and under SEM. (b)

• Synthesized silver-releasing PLA nanofibers appeared as a smooth fabric sheet (Fig.1a).
• SEM analysis of the nanofibers showed that the silver particle was not presence on the fiber surface (Fig.1b).

The presence of silver over the entire surface of silver-releasing nanofibrous scaffold was shown in XPS analysis (Fig 2).

2. DNA content

Silver-releasing nanofibrous scaffold supported the viability of hAMSC (red bar).
The silver-releasing scaffold did not diminish the growth of MRSA (purple bar).

3. Calcium deposition

Fig. 3. Alizarin red staining for calcium deposition on the scaffold by hAMSC and MRSA

Silver-releasing nanofibrous scaffold did not affect the osteogenic differentiation of hAMSC. However, deposited calcium by MRSA interfered the results in the co-culture system.

Fig. 4. Quantification of calcium deposition by hAMSC and MRSA

Silver-releasing nanofibrous scaffold did not affect the osteogenic differentiation of hAMSC. However, deposited calcium by MRSA interfered the results in the co-culture system.