Mehrdad Rafat, J Tissue Sci Eng 2014, 5:3
http://dx.doi.org/10.4172/2157-7552.S1.014

OMICS Group Conferences
Accelerating Scientific Discovery

3rd International Conference on
Tissue Science & Regenerative Medicine
September 24-26, 2014 Valencia Convention Centre, Spain

Multifactorial optimization of cell-cocooned collagen-alginate microspheres for cardiac tissue engineering

Mehrdad Rafat
Linköping University, Sweden

Summary: Tissue-specific delivery of stem cells holds the potential to regenerate damaged heart tissue and to restore its functions after Myocardial Infarction. Here we describe a novel cell encapsulation technique and an optimization method toward delivery of stem cells to damaged heart tissue. Induced pluripotent stem cells (iPS) were encapsulated in hybrid spheres of collagen and alginate and characterized for cell viability and spheres physical properties.

Background/Issue(s)/Objectives: Heart attack and failure is the number one cause of death in developed countries. Stem cell transplantation has been used as a promising therapy for heart disease. However, extensive cell attrition, and loss at the site of transplantation present a limit to therapeutic efficacy. We have hypothesized that cells viability, functionality, and target delivery will be enhanced by encapsulating the cells in hybrid collagen-alginate microspheres. Our main objectives are to develop cocooning techniques for effective delivery of viable stem cells to the damaged heart tissue and a mean to optimize microspheres properties with respect to size, shape, and encapsulated cells viability.

Design/Method: Hybrid spheres of collagen and alginate were produced using a coaxial air jet flow technique. The method involves the gelation of a collagen-alginate-cell solution in a calcium chloride bath. Microspheres loaded with iPS were washed and transferred to a Petri dish containing culture medium and incubated at 37°C. Microspheres formation and morphology (shape and size) and viability of the cells were monitored and evaluated using light microscopy techniques.

A 23 full multifactorial experimental design (MED) was employed to fabricate and test the spheres to determine optimum size, shape, and material composition. The effects of air flow rate, air gap distance and collagen to alginate ratio of the microspheres were studied.

Results: The MED results demonstrated that the air flow rate had a large effect on size, e.g. the higher the flow rate the smaller the spheres. Collagen to alginate ratio and air gap did not have a significant impact on size. The shape was, however, influenced by all factors. These findings allow us to fine-tune spheres to meet the size and shape criteria for different cell types. Spontaneous degradation occurred faster in spheres with higher collagen content compared to samples with less collagen. iPS cells were successfully encapsulated within the spheres and found viable over a 5-day period in culture.

Conclusions/Next steps: Preliminary results reveal that viable iPS cells could be encapsulated in hybrid collagen-alginate spheres. The impact of air flow rate and spheres composition on sphere's size and shape were determined. The next steps will include extensive biological and physical characterizations of microspheres, i.e. collagenase biodegradation, release mechanism of the cells, and injection in animal models.

Biography

Rafat received his Master's and PhD degrees in Chemical and Biological Engineering from the University of Ottawa (Canada) with specialization in Biomaterials and Tissue Engineering in 2002 and 2007, respectively. He is the co-inventor of four patents and the senior author of several refereed publications. Rafat co-invented the first clinically-tested bioengineered cornea at the University of Ottawa Eye Institute. He has further developed the bioengineered cornea technology in his group at Linköping University and taken it to the next level closer to commercialization. His research group's interests are mainly focused on Biomaterials Engineering and development of cell-interactive tissue-engineered materials as implantable scaffolds for ocular and cardiovascular applications such as bioengineered corneas and cardiac patches and nano and microencapsulation systems for controlled delivery of stem cells, drugs, and proteins to target tissues. His career spans a broad range of professional experiences-from working as a researcher and lecturer in academia, a medical devices regulator at the Canadian Government, and a consultant to biotech industries. He recently received two prestigious awards/grants from the European Research Agency including FP7 Marie Curie Incoming Fellowship Award (IIF) and FP7 Career Integration Grant. He is also the Co-Founder and Director of R&D, LinkoCare LifeSciences AB (Ltd.), a spinoff of Linköping University focused on commercialization of bioengineered corneas and other bioengineered tissues.

mehrdad.rafat@liu.se