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SBS-iTERM-BME Joint Seminar

Roles of Biomaterials and Surface Properties on Intimal Hyperplasia Formation in Small Diameter

Date: 7 June 2024, Friday

Time: 11:00am - 12 noon

Venue: Room G02, Lo Kwee-Seong Integrated Biomedical Sciences Building, Area 39, The Chinese University of Hong Kong

Abstract:

Synthetic small diameter (< 6 mm internal diameter) vascular grafts (sSDVG) are used in bypass of occluded peripheral arteries. However, there is a lack of commercially available sSDVG that provides acceptable long-term patency. sSDVG have high failure rate due to the thrombosis and intimal hyperplasia formation. While in situ endothelialization of sSDVG has been shown to be able to reduce thrombosis, reducing the formation of intimal hyperplasia formation could also enhance sSDVG patency. We hypothesize that both biomaterials properties and luminal surface properties could be modify to efficiently reduce the intimal hyperplasia formation.

Mechanical strength and compliance are important properties for sSDVG. Compliance mismatch between the synthetic graft and native artery has been speculated to be one of the main causes of intimal hyperplasia. However, changing the compliance of synthetic materials without altering material chemistry remains a challenge. Using biocompatible poly(vinyl alcohol) (PVA) hydrogel as a graft material, we fabricated PVA graft with tunable mechanical properties to investigate the role of graft compliance in the development of intimal hyperplasia and in vivo patency. The impact from terminal sterialization such as gamma irradiation and ethylene oxide (ETO) treatments on biomaterials properties were also examined.In our in vitro study, we showed that the compliance mismatch and the applied mechanical force could significantly affect the SMC phenotype and proliferation. To compare the influence of mechanical compliance in intimal hyperplasia formation in vivo, two groups of PVA small diameter grafts with low compliance and high compliance were fabricated by dip casting method and implanted in a clinically relevant rabbit carotid artery end-to-side anastomosis model for 4 weeks. We demonstrated that the grafts with compliance that more closely matched with rabbit carotid artery had lower anastomotic intimal hyperplasia formation and higher graft patency compared to low compliance grafts. The results suggested that reducing the compliance mismatch between the native artery and vascular grafts is beneficial for reducing intimal hyperplasia formation.

Luminal surface properties could also affect vascular cell growth. We have developed a surface modification strategy using fucoidan and luminal topography to enable fast in situ endothelialization of PVA. We also hypothesize that substrate topographies with various geometry, isotropy, and size could variously influence the behaviours of SMCs. Using a 16-pattern Multiarchitecture chip, SMC phenotype-modulating patterns were screened. The 2μm grating showed reduced proliferation, enhanced contractile phenotype and increased muscle-specific protein expression, regardless of the presence of platelet-derived growth factor (PDGF), which is a proinflammatory cytokine in vascular injury. The studies suggested that modulation of biomaterials properties could enhance long term performance of sSDVG.

Guest Speaker

Prof. Evelyn Yim

Professor & University Research Chair, Department of Chemical Engineering, University of Waterloo, Canada

Prof. Evelyn Yim received her Ph.D. in the Biomedical Engineering at the Johns Hopkins University before performing undergoing her post-doctoral training at the Johns Hopkins School of Medicine and in the Department of Biomedical Engineering at Duke University. Between 2007 and 2015 Evelyn worked in Singapore, where she held a joint appointment from the National University of Singapore, as faculty in the departments of Biomedical Engineering and Surgery, and the Mechanobiology Institute Singapore, a Research Center of Excellence supported by the National Research Foundation Singapore, as a principle investigator studying how chemical and biomechanical cues influence stem cell behavior.

Evelyn joined the Department of Chemical Engineering at the University of Waterloo in 2016. Experienced with nanofabrication technologies and stem cell culture, Evelyn and her group are interested to apply the knowledge biomaterial-stem cell interaction to direct stem cell differentiation and tissue regeneration for neural, vascular and corneal tissue engineering.

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Walk-in, no registration required