COLLEGE OF ENGINEERING AND COMPUTER SCIENCE
FLORIDA ATLANTIC UNIVERSITY

Announces the Ph.D. Dissertation Defense of

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for the degree of Doctor of Philosophy (Ph.D.)

"Engineering Channels in Porous Calcium Phosphate Bioceramic Scaffolds for Bone Tissue Regeneration"

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ABSTRACT OF DISSERTATION
Inadequate nutrition exchange and slow transportation in a porous scaffold often resulted in insufficient vasculature formation, which hindered rapid bone regeneration. In this study, interconnected porous beta-tricalcium phosphate (β-TCP) scaffolds with channeled geometry were fabricated. *In vitro* fluid transportation and degradation of the scaffolds were performed. Cell attachment, migration, proliferation, and differentiation were carried out under both static and dynamic culturing conditions. A computational simulation model and a series of immunofluorescent staining were implemented to understand the mechanism of cell behavior in respond to different scaffolds geometry. We then implanted scaffolds into rat critical-sized calvarial defects to further evaluate channels' function on bone regeneration *in vivo*. Results showed that multiple channeled geometry significantly accelerated the release of Ca^{2+} and increased the fluid diffusion efficiency. Moreover, multiple channels promoted human umbilical vein endothelial cells (HUVECs) infiltration, migration, besides prominently promoted alkaline phosphatase (ALP) activity, and up-regulated osteogenic

gene expression in human bone marrow mesenchymal stem cells (hBMSCs) at both static and dynamic culturing conditions *in vitro*. The expression of both cell migration related protein α5 and angiogenesis related protein CD31 were upregulated by multiple channels in HUVECs. And the expression of mechanosensing markers, focal adhesion kinase (FAK), polymeric filamentous actin (F-actin), and Yes-associated protein-1 (YAP-1) were highly stimulated by multiple channels in hBMSCs. The *in vivo* implantation and characterization results demonstrated more bone formation inside multiple-channeled scaffolds compared to non-channeled scaffolds. Multiple channels accelerated collagen type I, Bone Sialoprotein (Bsp), Osteocalcin (OC) protein expression prominently. The angiogenesis related protein CD31 staining displayed longer and more vasculature structures on multiple-channeled scaffolds compared to non-channeled scaffolds. Fluorescent images of the fluorochrome labeled samples exhibited considerably more mineral deposition on multiple-channeled scaffolds than non-channeled scaffolds. All the findings suggested that the addition of multiple channels in the porous β-TCP scaffold is very promising approach to promote vascularization and bone tissue regeneration.

BIOGRAPHICAL SKETCH

Born in Shenyang, China
B.S., Shenyang Agricultural University, Shenyang, Liaoning, China, 2010
M.S., Illinois Institute of Technology, Chicago, Illinois, 2013
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CONCERNING PERIOD OF PREPARATION
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Time in Preparation: 2015- 2019

Qualifying Examination Passed: Spring 2016

Published Papers:

R. van Lith, X. Wang, and G. Ameer, “Biodegradable Elastomers with Antioxidant and Retinoid-like Properties,” ACS Biomater. Sci. Eng., vol. 2, no. 2, pp. 268–277, Feb. 2016.

T. Yu, Q. Liu, T. Jiang, X. Wang, Y. Yang, and Y. Kang, “Channeled β-TCP Scaffolds Promoted Vascularization and Bone Augmentation in Mandible of Beagle Dogs,” Advanced Functional Materials, vol. 26, no. 37, pp. 6719–6727, Oct. 2016.

X. Wang, M. Lin, and Y. Kang, “Engineering Porous β-Tricalcium Phosphate (β-TCP) Scaffolds with Multiple Channels to Promote Cell Migration, Proliferation, and Angiogenesis,” ACS Appl Mater Interfaces, vol. 11, no. 9, pp. 9223–9232, Mar. 2019.

Z. Nie, X. Wang, L. Ren, and Y. Kang, “Effect of decellularized porcine bone matrix and synthetic bioceramic scaffolds on the osteogenic differentiation of mesenchymal stem cells”, Submitted.

X. Wang, Z. Nie, and Y. Kang, “Multiple Channels in β-tricalcium Phosphate (β-TCP) Scaffolds Promote Osteogenesis and Rapid Calvarial Bone Regeneration in Rats”, in preparation.