6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11 – 15 June 2018, Glasgow, UK

FINITE ELEMENT ANALYSIS OF PORES DESIGN AND TISSUE DIFFERENTIATION IN CEMENTLESS HIP PROSTHESIS

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Key Words: *Hip prosthesis; Pores design; Finite Element Analysis*

ABSTRACT

Hip prostheses are commonly used to fix the broken bones. The primary stability of the hip prosthesis is dependant on the peri-prosthesbone ingrowth into the porous coating. The bone ingrowth is a function of the mechanical behavior of the prosthesis at bone-prosthesis interface, coating and interference fit. In this study, 3D finite element models of simplified femur were constructued with hip prosthesis in commercially available software ABAQUS. Micromovements were determined to estimate the bone ingrowh. The bone ingrowth into the porous structure was predicted by using a mechano-regulatory model which was programmed in a user's subroutine. Homogenously distributed pores (200 µm and 800 µm in diameter) and functionally graded pores along the length of the prosthesis were introduced as a porous coating. Bone ingrowth was simulated using 25 µm and 12 µm micromovements. Functionally graded pore decreasing models gave the most homogenous bone distribution, the highest bone ingrowth (98%) with highest average Young's modulus of all tissue phenotypes approximately 4.1 GPa. Besides this, the volume of the initial callus increased to 8.33% in functionally graded pores as compared to the 200 µm pore size models which increased the bone volume.

ACKNOWLEDGEMENT

This paper was made possible by NPRP grant# NPRP 8-876-2-375 from the Qatar National Research Fund (a member of Qatar Foundation). The findings achieved herein are solely the responsibility of the authors.

REFERENCES

[1] Mukherjee K, Gupta S. Bone ingrowth around porous-coated acetabular implant: a three-dimensional finite element study using mechanoregulatory algorithm. Biomech Model Mechan. 2016;15:389-403.

[2] Abdul-Kadir MR, Hansen U, Klabunde R, Lucas D, Amis A. Finite element modelling of primary hip stem stability: The effect of interference fit. J Biomech. 2008;41:587-94.

[3] Puthumanapully PK, Browne M. Tissue Differentiation around a Short Stemmed Metaphyseal Loading Implant Employing a Modified Mechanoregulatory Algorithm: A Finite Element Study. J Orthopaed Res. 2011;29:787-94.