Influences of exercise durations on the dynamic bone-repair process by coupling polymer scaffold degradation and bone formation

Quan Shi[1], †,*Qiang Chen[1], †Zhi-Yong Li[1,2]

[1]Biomechanics Laboratory, School of Biological Science & Medical Engineering, Southeast University, 210096 Nanjing, PR China

[2]School of Chemistry, Physics and Mechanical Engineering, Queensland University of Technology(QUT), QLD 4001 Brisbane, Australia

*Presenting author: chenq999@gmail.com

†Corresponding author: chenq999@gmail.com; zylicam@gmail.com

Abstract

Bone disorders are common, and the biodegradable scaffold implantation is considered as an effective method to treat the bone disorders because of its promising properties, but understanding the dynamic process of the scaffold-bone system is extremely limited. In this study, basing on the representative volume cell (RVC) of a periodic scaffold, the influence of exercise durations on the bone regeneration was investigated by a microscale computational method, which coupled the polymer scaffold degradation and the bone remodeling. The scaffold degradation was described by a function of stochastic hydrolysis independent of the mechanical stimulation, and the bone was remodeled by a function of the mechanical stimulation, *i.e.*, strain energy density (SED), then, numerical simulations were performed to observe the dynamic bone-repair process. The result showed that the mechanical properties of the degraded scaffold and formed bone in the process were complementarily changed, and the greater exercise duration per day, the earlier the bone matures, but all exercise durations promoted the bone formation with a final approximate Young's modulus 2.2 GPa. This indicates that the great exercise duration could accelerate the bone-repair process but not improve the bone stiffness. The present study could be helpful to understand and monitor the dynamic process, and useful for the bone scaffold design in bone tissue engineering.

Keywords: Bone repair, Exercise durations, Scaffold degradation, Bone remodeling, Finite element model (FEM).