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Abstract

Bone tissue is a living composite material, providing mechanical and homeostatic functions, and able to constantly adapt its microstructure to changes in long term loading. This adaptation is conducted by a physiological process, known as "bone remodeling". This latter is manifested by interactions between osteoclasts and osteoblasts, and can be influenced by many local factors, via effects on bone cell differentiation and proliferation. In the current work, age and gender effects on damage rate evolution, throughout life, have been investigated using a mechanobiological finite element modeling. To achieve the aim, a mathematical model has been developed, coupling both cell activities and mechanical behavior of trabecular bone, under cyclic loadings. A series of computational simulations (ABAQUS/UMAT) has been performed on a 3D human proximal femur, allowing to investigate the effects of mechanical and biological parameters on mechanical strength of trabecular bone, in order to evaluate the fracture risk resulting from fatigue damage. The obtained results revealed that mechanical stimulus amplitude affects bone resorption and formation rates, and indicated that age and gender are major factors in bone response to the applied loadings.

Keywords: Bone tissue, bone remodeling, finite element method, fracture risk evaluation.