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AN INTEGRATED REMODELING TO FRACTURE MODEL OF BONE

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Bone is a living tissue that continually undergoes damage under normal everyday mechanical loadings. It maintains its structural integrity by a continuous process of damage detection and repair, and by adaptation to changes in the mechanical environment. These adaptive changes are regulated by the so-called process of bone remodeling. The aim of the current work is to develop an integrated remodeling-to-fracture model to simulate the bone remodeling process. For this purpose, models for the surface growth of continuum solid bodies are developed in the framework of the thermodynamics of irreversible processes, considering bone surface elasticity with damage properties, in which the damage stimuli is incorporated. Only external remodeling describing the shape evolution of bone due to is presently considered, the last process describing the shape evolution of bone due to apposition or resorption of minerals on its boundary. The growing bone external surface is endowed with a specific mechanical behavior elaborated from a surface potential, depending upon an elastic surface strain and the normal to the growing surface. Mechanical equilibrium is written in terms of a surface Eshelby stress and involves the surface curvature tensor; the surface remodeling velocity is related to the driving force for growth expressed versus Eshelby stress and effective density. Damage is directly incorporated into the effective surface density, the evolution of which versus time is incorporated in order to simulate fatigue damage development. The developed formalism is applied to simulate the interactions between bone external remodeling and damage.

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