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ABSTRACT:

A Bi-Dimensional Model Bridging Microdamage Evolution and Bone Remodeling: A Computational Study on a Human Femur

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The accumulation of microdamage renders bone tissues more vulnerable to excessive fatigue loading, which could potentially lead to fragility fractures. There is a need for an effective and noninvasive approach for predicting damage-prone regions. The literature lacks investigation into quasibrittle damage-informed remodelling, which is hypothesized to accurately capture the damage state. The present study aims to formulate a strain-driven microdamage-informed remodelling framework to accurately depict the quasibrittle nature of bone and to predict damage and adaptation state of a two-dimensional proximal human femur. Additionally, the potential of the proposed approach was assessed under the effects of the key remodelling parameters. Results imply that insufficient magnitude of remodelling, rapid stimulus diffusion, excessively fast remodelling, and inadequate diffusion coefficient promote substantial damage accumulation. The choice of adequate parameters reduces the femur fracture risk. The proposed model can serve clinicians as a predictor of likely femur fracture regions in elderly populations.

[1] Minku, et al. (2026) A quasi-brittle strain-driven microdamage-informed remodelling approach for predicting proximal human femur damage and remodelling patterns, Mathematics and Mechanics of Complex Systems, 101-124.