Mechanical Heterogeneity of Trabecular Bone at Nanoscale

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Abstract: This study examines the nanoscale mechanical architecture of trabecular bone, focusing on the heterogeneity inside the single trabeculae and its impact on the overall mechanical behaviors of trabecular bone. To achieve this, we employ Atomic Force Microscope (AFM) to characterize the graded structure and properties inside single trabeculae. Subsequently, finite element models are built based on the AFM images to calculate the deformation and strain of trabecular bone. Additionally, we explored the effects of various architectures on the overall mechanical behaviors of trabecular bone. By combining experimental and computational approaches, our research contributes to new understanding of bone mechanics and micro- and nano-structures. The findings offer prospects for bioinspired material design, including engineered beam-like structures and foams. The results provide valuable insights for developing advanced materials that mimic the intricate architecture of trabecular bone. These insights have potential implications for various biomedical applications and inspire innovative approaches in material design.