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A Multiscale Study of Bone Diseases and Treatments: From Biomechanics to Tissue Engineering

Yuxiao Zhou, Postdoctoral Fellow
School of Medicine, Johns Hopkins University

Abstract

Bone is a complex anisotropic hierarchical composite that consists of inorganic and organic components. Atomic force microscopy (AFM) was applied to map the surface morphology and elastic properties of bone from sub-millimeter to sub-micron scale. Bone is also a living material that adapts to mechanical stimulations through continuous modeling and remodeling activities. Mechanical testing coupled with micro X-ray computed tomography (micro-CT) enables concurrent non-invasive characterization of 3D full-field bone microstructures and bone mechanical properties. The mechanical behaviors and microstructures of bone in humans and animals affected by several bone diseases and the corresponding treatment methods were investigated. Besides bone diseases, critical-sized bone defects arising from acute trauma and cancer resections impact hundreds of thousands of patients each year and are challenging to treat. The application of stem cells in combination with tissue engineering scaffold-based treatments holds significant promise for replacing the current autograft gold standard. By optimizing mechanobiological cues that regulate bone regeneration, treatment outcome of critical-sized bone defects can be significantly improved. The research presented in this talk connects biomechanics and tissue engineering and paves way for developing customized biomedical devices to improve current orthopaedic treatment plans.

Bio sketch

Yuxiao Zhou is currently a postdoctoral fellow in School of Medicine at Johns Hopkins University. Prior to joining JHU, she received her Ph.D. degree in Mechanical Engineering from Pennsylvania State University in 2020, M.S. degree from Rutgers University-New Brunswick in 2015, and B.S. degree from Harbin Institute of Technology in 2012. She is currently an awardee of the Maryland Stem Cell Research Fund Postdoctoral Fellow. Her current research interests lie in the areas of regenerative medicine, 3D-printed tissue engineering bone scaffold, and biomechanics.

Department of Mechanical Engineering, Edward E. Whitacre Jr. College of Engineering
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