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Mapping bone biomechanical properties: 3D synchrotron imaging, multiscale modeling, numerical simulations, and related issues

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Recent studies have demonstrated the interest of coupling 3D high-resolution imaging with multiscale techniques to estimate bone mechanical properties. These estimates, in turn, can provide useful clinical information to assess bone biomechanical quality. Focusing on the human inferior femoral neck, our group has developed an original strategy coupling 3D synchrotron micro-computed tomography, continuum micromechanics and numerical simulation, allowing accurate 3D mapping of bone biomechanical properties (tissue-scale porosity, tissue mineral density, elastic coefficients) at the organ scale. In this contribution, we will review our most recent results and discuss them with respect to some issues related to the image treatment (threshold and partial volume effects), statistical description (homogeneity vs. heterogeneity) of data, as well as RVE definition and other modeling assumptions.

Keywords: Haversian Porosity, Tissue Mineral Density, Elastic Properties, Imaging, Continuum micromechanics