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High Resolution Peripheral Quantitative Computed Tomography for Assessment of Bone Quality

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The study of bone quality is motivated by the high morbidity, mortality, and societal cost of skeletal fractures. Over 10 million people are diagnosed with osteoporosis in the US alone, suffering 1.5 million osteoporotic fractures and costing the health care system over $17 billion annually. Accurate assessment of fracture risk is necessary to ensure that pharmacological and other interventions are appropriately administered. Currently, areal bone mineral density (aBMD) based on 2D dual-energy X-ray absorptiometry (DXA) is used to determine osteoporotic status and predict fracture risk. Though aBMD is a significant predictor of fracture risk, it does not completely explain bone strength or fracture incidence. The major limitation of aBMD is the lack of 3D information, which is necessary to distinguish between cortical and trabecular bone and to quantify bone geometry and microarchitecture. High resolution peripheral quantitative computed tomography (HR-pQCT) enables in vivo assessment of volumetric BMD within specific bone compartments as well as quantification of geometric and microarchitectural measures of bone quality. HR-pQCT studies have documented that trabecular bone microstructure alterations are associated with fracture risk independent of aBMD.... Cortical bone microstructure – specifically porosity – is a major determinant of strength, stiffness, and fracture toughness of cortical tissue and may further explain the aBMD-independent effect of age on bone fragility and fracture risk. The application of finite element analysis (FEA) to HR-pQCT data permits estimation of patient-specific bone strength, shown to be associated with fracture incidence independent of aBMD. This talk will describe the HR-pQCT scanner, established metrics of bone quality derived from HR-pQCT data, and novel analyses of bone quality currently in development. Cross-sectional and longitudinal HR-pQCT studies investigating the impact of aging, disease, injury, gender, race, and therapeutics on bone quality will be discussed.