TOMOSYNTHESIS IMAGING IN BONE QUALITY ASSESSMENT

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Vertebral fractures are the most common fragility fractures, and associated with significant complications as well as risk for additional fractures. Prediction of individuals at risk of fracture is largely based on bone mineral density (BMD) but this is not accurate. Additional information on the cancellous bone microstructure and mechanical properties is expected to increase prediction accuracy for vertebral fracture risk. However, obtaining microstructural and biomechanical details of vertebral bone using existing clinical imaging modalities is difficult due to concerns including resolution, radiation exposure and scan geometry. Digital tomosynthesis (DTS) is an imaging modality that has the potential to overcome these difficulties and prove microstructural and biomechanical metrics for assessment of vertebral bone quality. With the overall hypothesis that DTS is suitable for this task, we initiated a series of studies including cadaveric models to clinical demonstration studies to develop and establish DTS based methodologies for quantitative assessment of vertebral bone.

The studies undertaken focus on two approaches for utilization of DTS: 1) Textural analysis of vertebral cancellous bone structure using a single DTS acquisition, and 2) biomechanical analysis using two DTS acquisitions (one with patient lying and one with patient standing) combined with the computational digital volume correlation (DVC) technique. The experimental approaches include i) comparing DTS images to microcomputed tomography (mCT) images of cadaveric vertebrae, ii) correlating DTS derived metrics to experimentally determined mechanical properties of cadaveric vertebrae, and iii) application to clinically relevant cohorts in an attempt to demonstrate clinical utility.

In this overview, I will present the textural and biomechanical methodologies involved in DTS based bone characterization along with results from various in vitro and in vivo experiments, encouraging further development of these techniques. The development of the approach presented in this work is ultimately expected to improve understanding of etiologies of age- and disease-related bone fragility, assessment of fracture risk and assessment of efficacy of therapeutic and surgical interventions aiming to restore bone function.