Bone mechanical properties are closely related to bone mineral density (BMD) and trabecular structure. Both BMD and trabecular structure are predictors of osteoporosis. However, trabecular structure is often not assessable noninvasively. In this study, we combined BMD, patient age and bone structural features extracted from bone radiographs to improve the predictive power of bone mechanical properties. Forty-six femoral neck samples excised during total hip arthroplasties were radiographed using a setup that simulates clinical exposure of pelvis radiographs. The BMD of each sample was measured using a DPX densitometer and the BMD was normalized with respect to the width of the femoral neck. The radiographs were digitized and a ROI (64x64 pixels) was selected from the medial side of the femoral neck radiograph. Fractal-based textural features, Minkoswski dimension and trabecular orientation, were extracted from the ROI to characterize trabecular bone structure. Mechanical testing of 6.5x6.5 mm cubic specimens machined from each femoral neck yeilded the mechanical property of strength. Using BMD alone, the coefficients of determination (R-squared) was approximately 0.24. Using the normalized BMD, the R-squared increased to above 0.32. By adding patient age and structural features into the model, the R-squared further increased to 0.48. This study demonstrates the important contribution of normalized BMD, age, and structural features to the regression models and suggests a potential method for noninvasive evaluation of bone mechanical properties.
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