Differences in Lower Extremity Geometry with Gender, Age, Stature, and BMI

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ABSTRACT

CT scans were obtained from 100 patients approximately equally distributed over 10 year age groups and both genders. Lower extremity geometry was extracted from these scans, and surfaces of the tibia, femur, pelvis, and feet were defined using thresholding techniques. The following processes of landmarking, morphing, projecting, and analysis have been performed for the tibia and are being performed for the other bones. The locations of anatomic landmarks on the tibia surface from each subject were recorded. Corresponding landmark locations were recorded on a template mesh (a finite element mesh of a tibia bone). This mesh was then morphed and projected to the surfaces of each subject's tibia so that nodal locations of the morphed meshes were at corresponding locations on the surface of each bone. The morphing processed involved applying radial basis functions to the template nodal coordinates to obtain morphed nodal coordinates. Principal component analysis was used to characterize the variance in nodal coordinates across the morphed meshes from each subject. Regression was performed on principal component scores to identify the relationships between geometry and age, gender, stature, and BMI. Model predictions were used to identify meaningful variance in geometry with these occupant characteristics. To date, bone surfaces from all lower extremity bones have been extracted, but only tibia geometry has been statistically modeled. Analyses of femur, pelvis, and foot geometry will be completed shortly and included in this paper. Results of the analysis of tibia geometry indicate that, when controlling for all other occupant characteristics, there are no meaningful differences in tibia shape with gender, age, and BMI. When height is varied, increasing height increased bone size, but did not do so uniformly. This non-uniform change may indicate a gender effect since gender and stature are correlated variables. Graphs and figures representing the differences in lower extremity (pelvis, femur, tibia, and foot) shape with age, gender, stature, and BMI, the statistical model for all lower extremities, and a model describing cortical bone thickness in the femur and tibia will be included.